

The World of
PLANT LIFE

SECOND EDITION



BY

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To My Wife

WHO TYPED THE BOOK
AND WITHOUT WHOSE HELP
IT NEVER COULD HAVE BEEN COMPLETED

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Preface



MOST of us have a deep-seated liking for the companionship of plants. Their bright and cheery colors, their comforting shade, their varied fragrance, their suitability to our every mood, appeal to us. We like to have trees and flowers around us, in pots and window boxes, in our backyards and along our city streets, in our parks and botanical gardens. Gardening is a fundamental instinct; and there are countless garden clubs where kindred spirits meet to merge their personalities with those of dahlias, orchids or cacti. On a more extensive scale we have those state and national parks and forests whose sole purpose is to preserve particular forms of plant life—the Sequoia National Park, the State Redwood Parks, the Joshua Tree National Monument, the Sahuaro National Monument, and the Torreya and Royal Palm State Parks in Florida. Even if we are not interested in plants as individuals, what would our hunting and fishing trips, or our games of golf, be without the vegetation which gives a good share of the recreational value to those activities? The introduction of nature study into our camps, schools and colleges indicates a widespread desire to know more about our wild life, so much of which consists of plants.

There is, in the United States, an assortment of plant life equalled by few other countries. As we travel from the Canadian border to Key West we can see sub-arctic, temperate and sub-tropical members of the plant world in their native haunts, as well as many tropical species which have made themselves at home. Because of the almost riotous abandon of American topography, from the mountains of the far west to the eastern coastal swamps, and from the flat mid-western plains to the desert basins of the southwest, there is every conceivable type of habitat with its own peculiar forms of plant life. Few other countries can display such variety of coniferous and deciduous forests, prairies, cypress swamps, alpine gardens, palm groves and cactus forests. Increasing millions of Americans are able to get into their cars and trailers and spend months enjoying the natural beauties of our forty-eight states. It is unfortunate that so few of them, even with this fundamental interest in plants, have a nodding acquaintance with the plant world in that particular region through which they are travelling.

Even with this instinctive liking for flowers, trees and other plants, and with our intriguing variety of vegetation, many who love the out-of-doors are surprisingly ignorant of the names and interesting habits of its individual members. The green mantle of vegetation is often just so many flowers, leaves, trees, toadstools, and queer little green growths. Any attempt to get on speaking terms with plants, whether we stay at home or travel, usually ends disastrously. The reason is not hard to find. It is

not because of the lack of books on the subject, but, strangely enough, because there are too many! There is an overwhelming number of volumes dealing with particular plant groups or with regional floras, but in such detail and with such scientific language that the layman with an incipient interest often shies away from these possible sources of information.

This book was planned and written with the specific purpose of making the layman familiar with a few of the interesting plants, both native and introduced, which are found in the United States. It is hoped that it will serve as a card of introduction to the outstanding personalities in the plant world. There is a minimum of scientific terminology, though unfortunately some is essential in giving an orderly presentation of the plant world. That this is a most ambitious aim, beset with many pitfalls, any botanist can appreciate. Particularly difficult has been the task of knowing what to omit, since to a botanist all plants are interesting and it may seem inexcusable to pass by many of the species or families which must, because of physical limitations of a single volume, be omitted. The natural interests of the average American, at home and vacationing in our summer and winter playgrounds, has been the criterion for the inclusion of material in the following chapters. If, because of this book, the reader becomes encouraged to learn more about the various individuals in the plant kingdom; if he feels a closer kinship with them in his everyday life; if he appreciates more their characters and activities, and has added respect for their achievements—then the labor that has gone into this work will have been gladly expended.

There have been two other, perhaps less important, aims in the writing of this book. Many of the students in our schools and colleges have taken courses in botany. Far too often these courses include only microscopic study of plant anatomy or an identification of plants from herbarium sheets. But students are also interested in knowing about plants in their native haunts, in becoming familiar with members of the plant world which surround them in order to be able to call them by name, in finding out about species that possess unusual adaptive features or valuable economic properties. The origin and relationship of all our common cultivated flowers and food plants, the geographic distribution of species common in their particular region, these and countless other aspects of botany are as important as the knowledge of stem and leaf structure. For students of plant life, also, it is hoped that this book will be an introduction, but in a different way; an introduction to an alive, fascinating world which is often ignored in laboratory study.

And then there are the thousands of gardeners, members of horticultural societies, and botanists who know thoroughly one particular group of plants; there are the fern enthusiasts, the cactus specialists, the forestry experts, the bryologists, and algologists, and mycologists,—and all the other -ologists, ad infinitum. Many of these think of plants only in terms of their special interests. It is hoped that a few of these, after reading (leniently, we hope) the chapters dealing with their own specialties, will browse through the other chapters sufficiently to gain a well-rounded picture of the whole plant kingdom.

To such laymen, students and specialists this book is offered as a survey of THE WORLD OF PLANT LIFE.

Bel Air, Maryland

CLARENCE J. HYLANDER

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The World of
PLANT LIFE

Introduction



THE plant kingdom is more than a necessary background for the parade of the animal kingdom ; it is more than a colorful backdrop for the drama of animal life. Plants are an integral part of the world of living things whose every member is a growing, feeling, striving individual which seems very different superficially from an animal but in reality is faced with the same vital problems of existence.

We are surrounded by a living world, unique in its ability to confiscate and utilize energy, to increase in size by growth, to change its activities and structures as conditions in the environment change, to reproduce other individuals like themselves. In all these abilities the whole world of life—plant, animal and human—is decidedly different from the non-living realm of rocks and minerals and their derived products.

Many of the individuals in this universe of life we take for granted as being necessary but unexciting adjuncts to our living. Many more are but vaguely understood though we meet them every day. And many, many more are unknown because we are so completely unaware of their very existence.

This living world is made up of two kinds of organisms, each of which has developed a design for living quite different from the other. One pattern of life is exhibited by the animal kingdom and has resulted in the great diversity of three-quarters of a million species ; the other pattern characteristic of plant life has its own variety of some quarter million different species.

Since animals have so many structures and habits similar to our own, we are likely to think of them as being typical of the entire living world. But they are the specialized result of millions of years of experimenting with only one way of living, one pattern of existence. To be familiar with animal life alone is to limit one's understanding of the possibilities of life and to restrict one's appreciation of life.

Plant life is often enjoyed because of its esthetic appeal, but rarely is it appreciated in any degree commensurate with its vital importance in the beautifully balanced scheme of things, or do we realize how quietly and efficiently plants accomplish what many animals do so much more obviously. An elm tree makes no such fuss while it is absorbing sunshine, air and water with which to get its noon meal as that shown by a puppy lapping up its saucer of milk. The more one comes to know individuals in the plant world and the means by which they have adapted themselves to their surround-

ings and overcome obstacles to their progress, the more one is surprised that such unassuming neighbors can achieve so many things in such interesting ways.

Among the special accomplishments of plants we might mention their ability to utilize solar energy, their age span, their size range, and their importance as pioneers in colonizing the land.

Man himself has had little success in constructing solar engines. Millions upon millions of potential horsepower reach the earth in the form of sunshine—the rays incompletely made use of by the members of the animal kingdom, but each one efficiently trapped when it strikes the green screen of vegetation. With this great amount of energy at their disposal, plants can break down the carbon dioxide molecules of the atmosphere, as well as the water molecules, releasing the atoms of which these compounds are made. The carbon, hydrogen and oxygen atoms are then recombined in a new compound alien to the substances found anywhere in the earth's crust, a compound of greatest importance to the living world; for it is from it alone that living matter is initially constructed. This compound is a carbohydrate, an organic substance typified by the common starches and sugars and woody tissues of plants. Food from air and water! A superficially simple process, universally carried on by green plants, studied by chemists the world over, but with as yet insignificant success in its duplication by man.

Plants seem to have solved the problem of old age and death more satisfactorily than their animal relatives. What a trivial span is the century or two of life in the few long-lived reptiles and mammals when compared with the thousands of years in the life history of the Sequoias. There are dozens of tree species with recorded life spans of three and four hundred years; often they would have lived longer, had they not been cut down by man. Barring accidental death through fire, disease or lightning, trees are potentially immortal things which can go on growing almost forever within the limitations of physical bulk and available food.

Plants are not only the oldest of living things, they are also the largest. The average mammal (which is much smaller than man) is a tiny creature amid the forest vegetation which gives him his home. Even a whale or a Brontosaurus is a pigmy in the shadow of a three hundred and fifty foot Sequoia. At the opposite extreme of life, plants are the smallest living things. The bacteria come just within the range of our most powerful microscopes, many of them being only $1/250,000$ of an inch in length.

Plants are the pioneers of life; they are the advance guard in the colonizing of any land area by life. All the first living things were aquatic, developing in variety and abundance in oceans, rivers, lakes and hot springs. Then certain bold members of the plant kingdom managed to survive on the barren rocky land areas, perhaps left there periodically by the receding oceans or by drying ponds. Even today lichens and mosses are the pioneers, populating exposed bed rock and crevices in cliffs. They are followed by a host of grasses, ferns, shrubs and trees which capitalize what little humus and soil the pioneers before them were able to produce. As soon as the mat of vegetation is complete—often before—there comes a new world of worms, insects, amphibians, reptiles, birds and mammals to people a region which can now offer them that essential for existence—food. Where plants go animals may follow, for plants are the staff of life for the animal kingdom. Thus plants determine where and how animals shall live, since few animals can exist where plants or plant remains are entirely

absent; many millions of years ago plants formed the covering or vegetation which softened the harsh contours of the rocky crust and made terrestrial animal life possible. The kind of plant life has often determined the type of animal life; and its consequent development. In fact, perhaps one reason we as primates have arms as well as legs, instead of four legs, is that our ancestors lived amid *trees*! Is it too far fetched then to thank trees for the survival of an anatomical feature that has made civilization possible?

Since there is this universal dependence of the animal kingdom upon plants for the basic source of food, man is not unusual in his dependence upon agriculture. Through breeding and centuries of experimentation, man has improved the native varieties of fruits, seeds, leaves, stems and roots upon which his cave-dwelling ancestors relied for sustenance. In almost every group of plants, as we will see in the following chapters, there are some species which have become part of the human diet.

In addition to their value as foods, plants are important to man in many other ways. The wood produced by plant bodies as a part of their skeletal framework is the chief source of building materials, as well as the basis of pulp for paper, and cellulose for rayon and related products. The fibers of many plants give us textile products such as linen, cotton, jute and hemp. Products elaborated by various parts of the plant body become rubber, turpentine, drugs and beverages.

Yet even here, the web of inter-relations between plants and man does not end. Plants form a vegetation cover which prevents floods, keeps our reservoirs filled with pure drinking water, and prevents erosion by water or wind. The carbon dioxide, released in quantities by animal respiration, is removed from the atmosphere by plants during the process of converting it into food. In its place, the plant returns oxygen to the air thus purifying the atmosphere for us and other members of the animal kingdom.

All this is on the credit side of the ledger. To balance this, do we find many plants injurious and detrimental to mankind? Excepting the bacteria and fungi, the answer is no. There are a few objectionable weeds, a few poisonous plants; but they are an insignificant minority. And even among the bacteria and fungi we will later see that there are many useful species as well as harmful ones. So that on the whole, plants are a tremendous asset to mankind; whereas, unfortunately, the reverse can seldom be said. The greatest enemy of plant life is often man himself.

Most of us have little difficulty in differentiating between a plant and an animal. These two kinds of living things seem to present a clear-cut aspect of the duality of nature as she is today. Even to define a plant may seem unnecessary, since who would confuse the trout with the pondweeds through which it is swimming, a robin with the elm in which it is nesting, or a horse with the grass on which it is grazing!

In spite of the seeming idiocy of taking time to answer such a question, let us inquire "what is a plant?"

The plant is stationary, possesses no nervous system with which to react to changes in its surroundings, has no intelligence, and (most characteristic of all) develops green organs known as leaves. The animal by contrast moves about, responds

obviously and more or less immediately to stimuli, and periodically eats other animals or plants as food.

But how many realize that all these characteristics are not primary differences, nor are they universally true of all forms of plant and animal life. Many plants have no leaves (seaweeds, lichens, fungi, bacteria); many others are not green (fungi); many of the aquatic forms can swim about in animal fashion (algae, bacteria); and some are sensitive enough to trap small animal organisms and utilize them as food (insectivorous plants). Conversely many animals are stationary (corals, sea anemones); many others lack nervous systems, brains and sense organs (sponges, corals and other marine invertebrates).

After all, what is a plant and what is an animal? It is only in the case of the higher organisms that the distinction between the two is obvious and unquestionable. The lower in the scale of life we go, the more difficult it is to actually decide whether an organism is a plant or an animal. And there are whole groups of living things which combine enough characteristics of each so that both botanists and zoologists lay claim to the organisms in question; this is true of the flagellates, the motile green algae, the slime molds and at one time the bacteria.

The differences between these two kinds of living things are not the obvious ones found in a few of the higher representatives of both kingdoms, but rather *the different methods of doing the same thing*. In the living world there is more than one way of gaining a desired result; novelty within the limits of physical possibilities is the keynote of nature.

A primary requisite of all life is food. The physical basis of life is a complex organic compound known as protoplasm; no life has ever been found which is not made of protoplasm. Chemically this protoplasm is made up of some dozen or so common elements, chief of which are carbon, hydrogen, oxygen and nitrogen. It is this quartette of elements which is necessary for the formation of a protein, and protoplasm is a combination of many proteins. Living organisms cannot secure the proteins from the non-living environment; therefore it is evident that there must be a source of proteins somewhere or else life could never have originated nor could it go on as it does, era after era. This protein material comes from food.

Likewise, to be alive means a consumption of energy: protoplasm is like an automobile engine, in that it depends upon fuel as a source of energy to keep it going. This fuel for protoplasm, supplying the energy consumed in living, is also found in food.

The chief difference between a plant and an animal is the way it gets its food, for plants being living things require foods for energy and for building protoplasm just as animals do. Animals must secure their food from organic materials (that is, carbon compounds in the form of carbohydrates, fats and proteins); they cannot abstract the necessary elements out of which food is made from the various inorganic compounds found in nature. Thus animals are dependent upon other living things to manufacture their food for them. Animals usually get their food by ingesting plants or other animals, through a definite opening or mouth and subjecting this food to a digestive process before it can be assimilated.

Plants on the other hand are able to make their own food from various substances as they occur in the inorganic world. One of the gases of the atmosphere is carbon

dioxide, a compound containing oxygen and carbon; the two elements are so closely united however that it requires a great amount of energy to separate them. Carbon, the key element of living protoplasm, is therefore available only to those organisms capable of securing the carbon from carbon dioxide. This plants can do. Some do so by obtaining energy needed for the decomposition of carbon dioxide through the oxidation of various elements such as iron or sulphur; such plants need no green color, and are found among the bacteria. Others, by far the greater majority, are able to utilize solar energy; this is because of a green pigment (chlorophyll) present in their protoplasm which can as a result release the carbon from the carbon dioxide. From carbon dioxide and water, the plants then construct the carbohydrate molecules, rich in potential energy for life and basic for the building of protoplasm. Plants change their carbohydrate foods into proteins by the addition of nitrogen, which is absorbed from the nitrates in the soil. Plants are therefore independent of the animal kingdom, being able to absorb their food-making materials from such inorganic substances as air, water and earth minerals.

The plant and animal kingdoms separated along their divergent pathways millions of years ago, in that dim and little understood geologic past of which we have no fossil record. The ancestors of both, perhaps, were bacterial organisms capable of extracting the energy for protoplasm-building from minerals common in the earth's crust. Many of these primitive organisms were able to swim about due to delicate hair-like protoplasmic outgrowths; such organisms are to be found today, and are known as flagellates. The appearance of the unique compound chlorophyll and its union with protoplasm changed the entire aspect of life, made possible food manufacture in a far more efficient manner, and resulted in many-celled organisms in the variety found today in the plant world. The presence of chlorophyll was the fork in the road which has led in increasingly divergent directions along the two basic patterns of life from the ancestral bacterial and flagellate single-celled forms of life.

The unique value of the chlorophyll-protoplasm combination is its ability to intercept sun energy, which is many times more powerful and universally available than the meager energy rations of such inert compounds as those of iron and sulphur, previously the sole reliance of bacterial life. Utilizing solar energy, green protoplasm had a great advantage over colorless protoplasm. Thus the first green plants appeared. In the beginning they were microscopic, of a few cells, entirely water-dwellers similar to the pondscums and seaweeds of today. As the geologic eras slipped by they evolved into larger, more complex plants with structures and abilities that made the transition to land living possible; plants much like some of our moss and fern plants of today. At the same time there evolved a peculiar group of plants which lost their chlorophyll and developed the animal-habit of dependence upon organic sources for food, though the food was absorbed instead of ingested. These became the fungi. With vegetation adapted to land conditions the first vertebrates—crawling amphibians—were able to join in the conquest of the land. Fern plants gave rise to seed ferns; seed ferns to the true seed plants; and at the dawn of the most recent geologic era a wide variety of flowering plants had completed the colonization of the continents.

Plants differ from animals also in a few other ways. In the growth process, the animal has definitely limited proportions; each species has a fairly definite size and is composed of a definite number of organs (such as eyes, limbs, lungs, etc.). In plants

the size of each species varies within wider limits and is more dependent upon conditions in the environment. Many parts of plants have unlimited growth such as is found at the tip of the leafy shoot or of the root. Growth in thickness of trees is the result of the activities of a tissue beneath the bark known as cambium, which gives possibilities of girth limited only by physical conditions outside the tree. Some Californian Sequoias have been growing for the last five thousand years, and each is potentially capable of doing so forever. Though some plant organs such as leaves and flowers have distinctly limited growth, the number of such organs is far from constant for each species; each oak in a grove may vary widely in the number of leaves or acorns it produces.

Breathing is a function of living things whereby the oxygen from the atmosphere is brought to the protoplasm and its organic foods, whose oxidation results in the energy necessary for vital activities. Since movement in animals is brought about by muscular exertion, which in turn releases energy through respiration, organisms which move about require oxygen in greater quantities and more continuously than those which stand still. The stationary bodies of most plants "breathe" leisurely by a simple diffusion of gases in and out of the minute pores in the leaves or through the less impervious portions of the bark; while in animals, breathing has necessitated a respiratory mechanism for the forcible exchange of gases.

Reproduction is for plants as for animals the formation of minute living cells which can separate from the parent and grow into new organisms. If each reproductive cell grows into another organism by itself the process is termed asexual and there is only one parent; such reproductive cells are known as spores. This method is far more common in plants than in animals. When the reproductive cells are of the type that must unite in pairs, two cells forming one fused cell before development into a new organism, the process is sexual reproduction. The two reproductive cells are known as egg and sperm, the individual producing the former is called female, that producing the latter, male. Plants also reproduce sexually, but with certain restrictions, for animals can by their own movement bring egg and sperm cells together; most plants cannot. It is only when the plants live in water or in moist situations that the released sperm can swim to the egg cells. Seaweeds have developed sexual reproduction by sperm and egg to a high degree. Land plants tend to minimize the sexual phase of reproduction.

The flower is the reproductive organ of all the higher land plants, and is adapted for producing new plants under terrestrial limitations, where motile sperm could never survive. Each flower produces pollen grains, which are really spores, that can be carried about in the air by various external agencies such as wind or insects. When the pollen reaches the pistil of a flower it "germinates"; in other words, grows into a minute male plant which brings the male nucleus (corresponding to the sperm) in contact with the female nucleus (corresponding to the egg). Reproduction results in a fertilized egg, which develops into an embryo, in plants as well as animals. The ordinary land plant protects its embryo with an apparent solicitude which many animals might well emulate. The embryo is provided with a large amount of stored food and various protective coats, the whole being termed the seed. Often the seed is in turn enveloped by special tissues which protect it and secure its dispersal,—the fruit.

Thus we see that the obvious differences between animals and plants which we first mentioned are not primary ones. The stationary condition is the result of the special way by which plants get their food, and is not an inadequate or imperfect condition in which plants are inferior to animals. To be able to move about is in itself, biologically, of no advantage; it uses up costly food materials as energy and requires complex tissues and organs to produce the motion. Since the plant can get its food by standing still it would be the height of stupidity for it to move about after it. The animal, at least on land, cannot root itself in one spot; the food it requires would hardly walk into its open mouth in sufficient quantity for sustenance. Animal locomotion is merely a means to an end; when the animal can get its food by standing still it is as sedentary as a plant—witness the sponges and corals.

It is this dependence upon locomotion which has brought about most of the other superficial differences between animals and plants. To move about requires a high degree of consciousness of changes in one's surroundings; sense organs, nerves and brains come into existence. It may be that plants lack brains because such coordinating organs are unnecessary. Though lacking in special sense organs, plants are not lacking in senses. They are sensitive to gravity, pressure, light and various physical stimuli; variations in any of these cause responses on the part of the plant. Such responses are often not far removed from the reflex actions of animals.

The plant kingdom is not, however, made up of a homogeneous number of plants, each quite similar to the others. The plant pattern of existence does not preclude minor variations on the main theme. Some plants have developed, and passed on to their descendants, special abilities and peculiar structures. All these descendants therefore resemble each other more closely than they do any other plant.

For example, almost a quarter of all known plants have lost their chlorophyll and evolved into plants with parasitic or saprophytic habits of existence. The Fungi are colorless and for this reason, like the animals, must subsist upon organic food previously elaborated by green plants. This they get by absorbing it from living or dead tissue, both plant and animal.

Plants also differ among themselves in the complexity of the vegetative body,—that portion of the plant that takes care of maintenance of the individual. Some are single-celled and microscopic, others are many-celled and visible to the unaided eye. Some of the many-celled species are made up of cells each of which is capable of carrying on all the functions of living; while others have division of labor among the cells, certain cells being specialized for food manufacture, others for absorption of water, still others for conduction of materials. The ordinary tree made up of many different tissues and organs is a complex plant in contrast to the simple undifferentiated body of a seaweed.

In addition, plants differ in reproductive habits. Many of the simpler aquatic forms rely entirely upon sexual reproduction by egg and sperm, or upon swimming spores. Most land plants, on the other hand, have brought asexual reproduction by spores to a high degree of efficiency, this spore-producing habit being especially noticeable in the mosses, ferns, and mushrooms. In the flowering plants there has appeared a highly specialized spore-producing organ, the flower, which has been so successful that the majority of land plants today are flowering plants.

The plant world is made up of about 250,000 different "kinds" of plants; each "kind" of plant is known as a *species*, and really is a group of individuals so closely related that they do not apparently differ from each other in any important way. Such a plant species is the Red Oak, or the White Pine, or the New England Aster. Two or more species are grouped by biologists into a *genus*, if the species have more characteristics in common with each other than with any other kind of plant. Thus the Red Oak and the White Oak are two species of the oak genus; all maples are in the same genus, as are all pines, or asters, or roses. In speaking of a plant, scientifically, we mention both the genus and the species name, the former first. Thus the White Pine is known as *Pinus* (the genus name) *Strobus* (the species name). Pitch Pine is *Pinus rigida*, or just *P. rigida*. Most people can differentiate between genera (plural of genus) such as oaks, pines and maples more easily than between species,—such as the different kinds of pines. In some cases a genus may consist of but one species.

Just as species which are like each other are grouped into genera, so are genera which have characters in common grouped into a *family*, the Rose Family includes such genera as Roses, Apples, Hawthorns and Strawberry. Related families are grouped into larger divisions of the plant kingdom (such as orders and classes and phyla). The phylum is the largest group of related plant species, the whole plant kingdom being subdivided into but a dozen or so phyla.

Before we begin our survey of the plant world, it might be well for us to briefly view some of the characteristics and representative members of each of the great phyla of the plant kingdom.

The first seven of the following phyla are frequently grouped together and called Thallophytes. They are characterized by a plant body known as a thallus, devoid of complex organs such as roots, stems and leaves. The Thallophytes can well be called the leafless plants. They are in addition flowerless plants, for all of them reproduce by spores or by sperm-and-egg methods. The remaining three phyla are sometimes known as the Cormophytes, or cormus plants. These are characterized by vegetative specialization into roots, stems, and leaves; the most highly developed of these being the Flowering Plants. The phyla are considered in order of increasing complexity.

Phylum 1 The Fission Plants (*Schizophyta*) This is the simplest and most primitive group of plants. The group is characterized by a complete lack of sexual reproduction, and a primitive type of cell structure. There are two well-defined sub-groups, or classes: the Bacteria, which lack chlorophyll, and the Blue-green Algae, which possess chlorophyll. Both classes are made up of microscopic or minute plants, chiefly aquatic (Chapter 1).

Phylum 2. The Green Algae (*Chlorophyta*) These are the simplest chlorophyll-bearing plants. Some of them are microscopic and make up an invisible plankton world; others are many-celled and often visible as slimy masses of green (Chapter 2). The largest of them are moss-like in habit, reaching the maximum development in the oceans.

Phylum 3 The Yellow-green Algae (*Chrysophyta*). In this as in the preceding groups we are still dealing with aquatic plants, predominantly microscopic or small in size. These plants possess, in addition to the chlorophyll, a yellow pigment which

is present in such quantities as to give the cells a golden-green color. A peculiar habit of these plants is the storing of reserve food in the form of oil rather than the starch common to the Green Algae and the higher plants. Typical of the phylum is the widely-distributed floating world of diatoms, which make up the bulk of vegetation in the upper waters of all oceans and bodies of fresh water (Chapter 2).

Phylum 4. The Brown Algae (Phaeophyta). These are the common dark-brown and olive-green seaweeds exposed on rocky shores as the tide recedes. Although some of them are thread-like and mossy in habit, the majority develop massive if flabby plant bodies which often imitate the structures and forms of land plants. The submarine forests of kelp include species of Brown Algae which often reach a length of several hundred feet. The characteristic of this phylum which gives it its name is a brown pigment associated with the chlorophyll, which often completely obscures the green color also present (Chapter 3).

Phylum 5. The Red Algae (Rhodophyta). These are the frailer and more delicate seaweeds which grow at and below low-tide mark where life is less strenuous than in the inter-tidal zone. The red seaweeds, or sea-mosses as they are also called, have a red pigment which often completely masks the chlorophyll and gives the plants the unusual purple, lavender or pink shades commonly present (Chapter 3).

All the preceding phyla of thallus plants have included chlorophyll-bearing species. The following two phyla of thallus plants have in common a complete absence of chlorophyll; as a result they subsist on dead or living vegetation and animal life.

Phylum 6. The Slime Molds (Myxophyta). These are rather uncommon terrestrial plants which haunt the damp and gloomy shades of the forest, living on rotting tree trunks and other organic debris. The plant body consists of a slimy mass known as a plasmodium which has (for plants) the unique ability to slowly crawl over the substratum like a giant Amoeba. This animal characteristic is coupled with typical plant reproduction by spore cases (Chapter 4).

Phylum 7. The Fungi (Mycophyta). In number of species this phylum exceeds all the preceding phyla combined; in economic importance it rivals the bacteria. Fungi have a thread-like plant body known as a mycelium which grows throughout the substratum serving as a source of nourishment for the fungus, whether that substratum be a loaf of bread, a shoe or the trunk of a tree. Some fungi are aquatic, but the majority are terrestrial, living in shaded, moist situations where there is available organic food. Sunlight is not only unnecessary for their development but actually fatal to them, since their delicate bodies are made up of watery tissues which cannot stand the desiccation following continued exposure to direct sunlight. There are four classes in this important phylum.

The Algae-like Fungi (*Phycomycetes*) are small thread-like fungi known as molds and mildews (Chapter 5).

The Ascus-Fungi (*Ascomycetes*) are unicellular plants, such as the common Yeast, or small thread-like fungi causing many plant diseases. A few are massive forms, represented by the edible Truffles. A characteristic of this class is the special asexual reproductive organ known as an ascus, resembling a pea pod full of peas; instead of seeds, the pod contains a definite number of spores (Chapter 5).

The Lichens are unique plants in that they consist of a partnership between certain Ascus Fungi and Blue-green or Green Algae. Both plants seem to profit by the

association, which is known as symbiosis. Various plant body types are built up by these cooperating fungi and algae, exemplified by the Reindeer Moss and the Old Man's Beard of the northern woods (Chapter 6).

The best known of the Fungi are the mushrooms; they are representative of the last class, known as the Basidium Fungi, (*Basidiomycetes*) because of the peculiar reproductive organs. The spores are borne on swollen projecting cells known as basidia, which are located on the partitions or gills beneath the "cap" of the mushroom (Chapter 4).

The following three phyla constitute the balance of the plant kingdom and include those plants with various combinations of leafy stems, special absorbing root systems and other features which make terrestrial living possible. They are the common land plants, a few of which have adapted themselves to an aquatic existence and become water-dwellers.

Phylum 8. The Moss Plants (Bryophyta). These, the simplest and lowliest of the land plants, all small and inconspicuous, and poorly equipped in most instances to live in very dry or exposed land situations. They are generally found on the shady sides of ravines, the dripping walls of caves, streams and waterfalls. There are two classes in the phylum. The Liverworts (*Hepaticae*) are prostrate or creeping plants with or without leaf-like structures, often growing as thallus over stones and twigs submerged in water. The "leafy" species have thin and delicate leaves able to survive only in very damp locations (Chapter 7).

The Mosses (*Musci*) are either creeping or erect plants with leaf-like structures and a primitive absorbing system of rhizoids, on the whole fairly well adapted for land dwelling (Chapter 7).

Phylum 9. The Fern Plants (Pteridophyta). In some of the moss plants there are stems and leaf-like organs, but in no case are there special conductive tissues for carrying food and liquids to various parts of the plant body. Such vascular tissues appear for the first time in the fern plants. In addition there are true roots instead of the filamentous rhizoids of the mosses. The ferns reproduce by spores which are produced on the under side of the leaves or in special cone-like structures; in the higher plants the spores are produced in cones or in flowers.

Living ferns are grouped into four classes, each of which includes many fossil representatives as well. Some of the prehistoric fern groups, abundant at the end of the Paleozoic Era, have completely died out.

The True Ferns (*Filicineae*) include a wide variety of plants which usually possess large and intricately subdivided leaves. They vary in size from the small rock-inhabiting Polypody to the tree ferns of the tropics. About four fifths of all the fern species are found in this group. (Chapter 8).

The Primitive Ferns (*Psilophytineae*) include a few tropical species of rootless, epiphytic plants which are a relict of the pioneer days when the first vascular plants appeared on dry land. The extinct species are of unusual evolutionary interest, since they indicate the probable types of plant life which first inhabited the land (Chapter 9).

The Horse Tails (*Equisetineae*) today are rush-like and grass-like plants of wet swampy habitats as well as of such inhospitable locations as railroad embankments. They have jointed stems and very small leaves in whorls on the green stems and

branches. Prehistoric species formed the first forests, and their remains resulted in the coal deposits which are today such a valuable store of energy (Chapter 9).

The Club Mosses (*Lycopodineae*) and the related Ground Pines are small, herbaceous plants with short or creeping stems and small overlapping cedar-like leaves. They resemble miniature evergreens rather than mosses. They too had prehistoric relatives which were forest trees and important in coal formation (Chapter 9).

Phylum 10. The Seed Plants (Spermatophyta). In this, the highest group of plants, we find the greatest complexity of both vegetative and reproductive habits. The root-stem-leaf combination has become successfully adapted to a wide variety of living conditions, forming forests and prairies, tundra and alpine meadows. So successful has the seed habit been, that at least half of the plant kingdom belongs to this phylum; a conservative estimate would put the known species of Seed Plants at about 125,000. It is the care for the nourishment, protection and dispersal of the embryonic plant which has given the Seed Plants their great advantage over all other groups of land plants.

The classification of the Seed Plants is a complex subject; for though there are only two subdivisions, there are over fifty orders and at least a hundred common families. Out of this bewildering assemblage we can choose only those groups which are of peculiar value or significance to the human race, or those which are of interest because of their unusual appearance or habits.

The *Spermatophyta* are subdivided into the *Gymnosperms* and the *Angiosperms*. The subdivision *Gymnosperms*, or Naked-seed Plants, includes the more primitive seed plants, reproducing by catkins or cones and with seeds unprotected by a fruit. Their leaves may be fern-like, strap-shaped, needle-shaped or scale-like. Most of the species are trees. The following are representative Gymnosperm types. The Cycads are plants with large fern-like leaves, short massive trunks and pithy stems, common to tropical countries (Chapter 10). The Maiden-hair Tree, with small wedge-shaped leaves and catkin-like flowers, is common to the Orient but widely cultivated in the United States (Chapter 10). The Mormon Tea and its relatives are semi-woody desert plants (Chapter 10). The Conifers include the cone-bearing trees and shrubs, usually evergreen as in the case of the pines and cedars (Chapter 11).

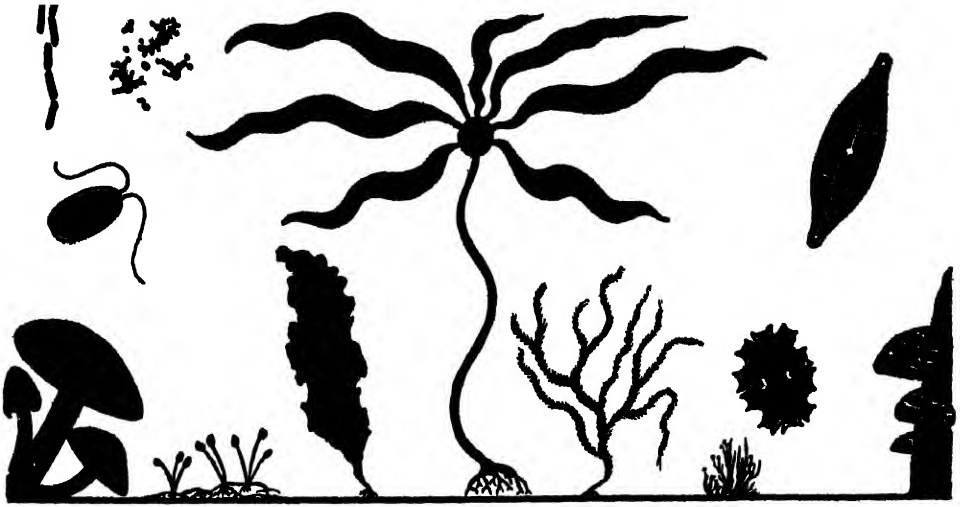
The subdivision *Angiosperms* includes those species which have flowers, and seeds protected by a fruit. The Angiosperms form a large and complex group of flowering plants, with the various families and orders generally grouped under two main headings, the Dicotyledoneae and the Monocotyledoneae,—unwieldy terms sometimes shortened to Dicots and Monocots.

The Dicots can be recognized by their netted veined leaves, the woody stems growing annually in thickness, the flower parts (sepals, petals, stamens or pistils) generally in fours or fives, the seed containing a plant embryo with two seed-leaves or cotyledons. On the basis of flower structure the Dicot plants can be grouped into three main sublasses. (1) The *Monochlamydeae* which are plants with flowers in catkins or cones, without petals and sepals or with undifferentiated ones if they are present. Here we find, among others, the Birch Family, the Walnut Family, the Mulberry Family, the Buckwheat Family, the Fig-marigold Family and the Pink Family (Chapters 12–15). (2) The *Dialypetalae*, which are plants with flowers made up of distinct petals and sepals, always separate from each other. This is considered

by some botanists the most primitive group of the Angiosperms. It includes the Buttercup Family, the Magnolia Family, the Laurel Family, the Poppy Family, the Mustard Family, the Pea Family, the Rose Family, the Geranium Family, the Cacti, the Insectivorous Plants, the Citrus Fruits, the Carrot Family and the Mallows (Chapters 16-33). (3) The *Sympetalae*, which are the plants with flowers characterized by petals and sepals fused together, sometimes forming a tubular corolla. In this group, among other families, are the Heath Family, the Wintergreen Family, the Olive Family, the Milkweed Family, the Mint Family, the Honeysuckle Family, the Nightshade Family and the Sunflower Family (Chapters 34-38).

The Monocots can usually be recognized by their long tapering leaves with parallel veins; pithy stems lacking wood and annual rings; flower parts in threes or sixes; and embryo plant with only one cotyledon. Unlike the Dicots, few of the Monocots except the Palms are trees. A few of the common families include the Grasses, the Cat-tails, the Aroids, the Palms, the Lilies, the Irises and the Orchids (Chapters 39-42).

With such a preview of the whole plant kingdom in mind, realizing the unique activities which set plants apart from animals as well as the many basic processes which are common to both, and appreciating enough of the various habits and structures found among plants to understand the classification of plants, we can now set out upon an excursion into the realm of each of these phyla.



THALLOPHYTA

The THALLUS SPORE PLANTS—*Thallophyta*—are the lowliest forms of plant life, living organisms which lack the complex tissues and organs such as roots, stems and leaves found in the higher land plants. They produce no colorful flowers, grow no fruits. Many of them live their lives entirely unseen and unknown beneath the surface of lakes and oceans. Some are green, such as the Green Algae which form silky thread-like growths or broad expansions in fresh and salt water, the Brown Algae with such impressive members as the Kelps, the Red Algae with such delicate representatives as the frail Sea Mosses growing deep in the oceans at the lower limit of light penetration. Others are colorless and live as parasites or saprophytes: the Bacteria, many of which are beneficial, others harmful, the fleshy Mushrooms and woody Bracket Fungi, the numerous Molds, Mildews, and Blights which infest self-respecting green plants, the strange Lichens, Nature's attempt at co-operative living. These comprise this little-known group of plants which have been content to carry on the simplicity of structure which millions of years ago characterized all forms of plant life.

CHAPTER I

The Most Primitive Forms of Plant Life



IT is fitting that we should begin our survey of the plant kingdom with those representatives which are at the foot of the ladder of plant evolution and which demonstrate what plants can do in their simplest and least complex form.

Many of these simple plants are minute forms of life, invisible as individuals except under the microscope—known to scientists as micro-organisms, to laymen as microbes or germs. They represent the reduction of living matter to the smallest possible dimension, that of a single cell. Most of these micro-organisms are unicellular; the few that are multicellular consist of rows of cells which form delicate filaments, or of masses of cells in formless colonies. When the plant body is a single cell, it is, as we naturally would expect, much simpler in appearance and much less complex in its activities than a many-celled organism such as a human being who is made up of trillions of different and highly specialized cells.

Animal micro-organisms are known as Protozoa, a few of which are of economic importance as disease agents. Plant micro-organisms are either algae, fungi, or bacteria. The algae have in their protoplasm the green pigment chlorophyll and are thus able to manufacture their own food. The fungi lack chlorophyll and are therefore dependent upon other plants and animals for their food; yeasts are common fungus micro-organisms. The bacteria, also non-green plants, are of much simpler structure than the fungi. The yeast plants will be considered in a later chapter; at this moment we will restrict our attention to the bacteria and certain of their relatives known as the Blue-green Algae.

The word "bacteria" often suggests to the average person some minute and diabolic bug lying in wait to pounce upon an unsuspecting human and use him as a host for itself and its countless descendants. Such a person thinks of the terrible plagues which have wiped out entire populations of various countries, of the ravaging ailments of the human race, of the expense and discomfort and sorrow which follow in the wake of these tiny organisms.

It is true that some bacteria are agents of disease. But it is also true, and not so well known, that for every disease-producing micro-organism there are hundreds which are not only beneficial to other forms of life, but actually indispensable for their continued existence.

That bacteria are plants may come as a surprise to many, since these living

things seem far removed indeed from the popular conception of a plant. The bacteria are not green, as most plants are; in this respect they resemble the fungi whose thousands of species are classed as plants even though they lack chlorophyll. When we discover that the cell-wall of bacteria is more frequently made up of a chitin-like substance similar to that found in insects than of the cellulose of a typical plant cell, and when we learn that many bacteria are capable of independent locomotion in a fashion similar to that of the Protozoa, the bewilderment may be complete.

After all, what is a plant and what is an animal? The lower we go in the scale of life the harder it is to decide indisputably whether an organism belongs to one group or the other. There are many groups of living things which combine both plant and animal characters in a fashion most embarrassing to those biologists who wish to pigeon-hole all living things either as plants or animals. Bacteria have some of these aggravating character combinations. But in the final analysis, the fundamental difference between a plant and an animal lies in its method of nutrition. Since animals ingest their food while plants absorb theirs, the bacteria are in this respect typical plants. In addition, the only other group of organisms to which the bacteria are closely related is the Blue-green Algae, (*Cyanophyceae*)—undoubtedly plants. Together, these two groups make up the first phylum of the plant kingdom, the *Schizophyta* (Fission Plants—so called because of their characteristic habit of reproducing by splitting in half).

STRUCTURE OF BACTERIA

The word "bacteria" is derived from the Greek "bakterion", meaning a little stick. This name was given them because the first bacteria to be recognized were the rod-shaped species now known as bacilli. Bacteria are the smallest living things, varying in size within microscopic limits. If we were to place individuals of the largest species end to end for an inch there would be 250 of them, and if we used the smallest species, there would be 250,000! It is evident that there can be thousands of bacteria in a single drop of water. A single red corpuscle from human blood weighs about 50,000 times as much as an average bacterial cell.

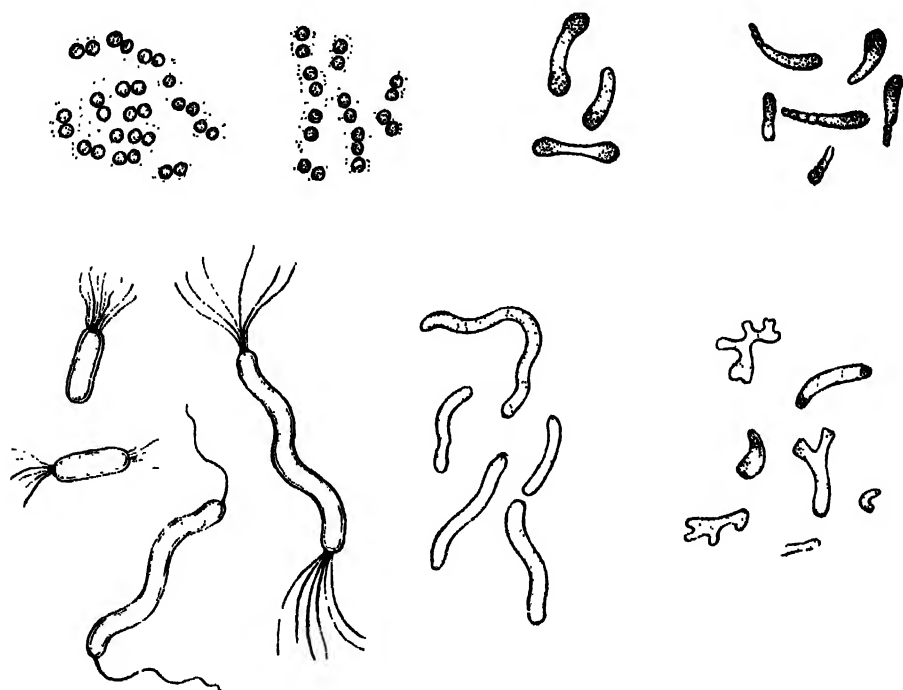
Being so small, it is no wonder that the bacteria were long unnoticed while scientists were exploring the visible living world. They were discovered less than three hundred years ago, long after Columbus had stumbled upon America—which was, after all, an object much easier for discovery than a bacillus. It was not until 1683 that a Dutch janitor by the name of Leeuwenhoek, making his own crude microscopes, first observed bacteria.

In the time of Pasteur it was proved that bacteria were living organisms, instead of particles generated spontaneously in decaying flesh. Knowledge of their relation to decay, fermentation and disease has all been the work of biologists since 1860. Even now, except with the electron microscope, we can make out little of the structure of these exceedingly minute plants.

There is a cell wall, often very thin, which protects the underlying protoplasm; this cell wall frequently develops a thick gelatinous sheath or capsule to further protect the living material from unfavorable changes in the environment. The protoplasm itself is unique in that it is not organized into typical nucleus and cytoplasm; what

there is of the chromatin material, considered so important in the passing on of hereditary traits, is often scattered throughout the unorganized cytoplasm.

Bacteria are of three shapes. Smallest and simplest of all is the spherical body of the coccus type. When these cells, increasing their number by growth, are arranged like beads on a string they are called streptococci; when in grape-like bunches, staphylococci. Much larger are the rod-shaped cells of the bacilli which are able to swim about in liquids such as blood or milk because they possess hair-like projections from



BACTERIA

Upper Row: Gonorrhea, Pneumonia Cocci; Tuberculosis, Diphtheria Bacilli.
Lower Row: Bacilli and Spirilla showing hair-like flagella; Cholera Spirilla; Root Tubercle Bacteria.

their cell walls, known as flagella. The flagella beat to and fro much like oars. A mass of bacilli actively moving about, their flagella vibrating, resembles a swarm of gnats. There may be as many as twenty-four of these flagella on either side of the bacillus. The third type of bacterial cell is the spirillum, each cell spirally twisted like a cork-screw.

DISTRIBUTION OF BACTERIA

Bacteria are ubiquitous plants. There are few places on the earth, above it, or below it where bacteria can not be found. They are abundant in both fresh and salt water, their numbers increasing as the water becomes more stagnant and filled with organic debris.

Of the many bacteria that find their way into water, most are harmless, derived from the soil, the atmosphere and decaying vegetation over which the water has flowed. They include the pigmented bacteria, the decay bacteria and a dozen other harmless species. Pathogenic bacteria which at times get into water and are spread in that way, include those causing cholera and typhoid fever. To be safe, drinking water should average not more than one hundred bacteria per cubic centimeter.

Though their living requirements are best fulfilled in water at temperatures between 22 and 37 degrees Centigrade, there are species capable of living in hot springs, others that thrive on the chill surfaces of snow banks and glaciers.

Many bacteria are constantly being carried about by the atmosphere, but still air contains practically no bacteria as compared with air in motion. Most of the air-borne bacteria and bacterial spores are carried on dust particles; after rain storms the bacterial content of the air is very low. Few of the air-borne bacteria are disease-producing varieties.

Bacteria have been collected commonly at altitudes of one and two thousand feet; at times, even at heights of six thousand feet. Yet aerial transmission of diseases is rare, few pathogenic bacteria being viable even in city atmosphere. The air bacteria are harmless species, such as the common *Bacillus subtilis* and various branching colonial forms.

Strangest of all, the bacteria form an abundant subterranean flora, living to depths of many feet in the dark recesses between the soil particles. One investigator has estimated that soil microbes are present on the average of 100,000 per cubic centimeter of soil.

REPRODUCTION AMONG BACTERIA

Bacteria are ambitious plants with little respect for birth control. Their usual mode of reproduction is of the simplest yet most efficient type found in this living world. When a bacterium becomes mature a constriction develops across its middle; thinner and thinner becomes the strand of protoplasm connecting the two halves until finally they separate. Two daughter bacteria have been formed from what was a parent cell. At every birth, the parent ceases to exist! Such reproduction by fission takes place at frequent intervals, under favorable circumstances three times an hour. Even with a conservative reproduction rate of once an hour, in two days the descendants of a single bacterium numbers 281,000,000,000. Such rapid reproduction takes place when the bacteria are surrounded by plenty of food, suitable temperature and ample space. Under unfavorable conditions the bacteria reduce their living contents to small rounded cells known as spores, well protected by thick resistant walls. In the spore stage, bacteria go into a period of suspended animation during which they can withstand unusual desiccation, intense heat or extreme cold. Some spores have been found alive after being subjected to boiling for sixteen hours. Spores of anthrax have been "brought to life" after fifteen years of inactivity.

NON-PATHOGENIC BACTERIA

For their nutrition, bacteria, as do all plants, require a constant supply of both energy and carbon. Lacking the chlorophyll, bacteria can not rely upon the radiant energy of sunlight. Some bacteria obtain the energy necessary for getting the carbon

from the carbon dioxide of the atmosphere by oxidizing various inorganic substances found in the earth's crust. This is the simplest method of energy-intake, and is found only in certain bacteria. It is believed by many scientists that this represents the most primitive way in which life can obtain its energy for living. So it may well be that these bacteria show us today how the first forms of life were able to build up complex organic compounds and protoplasm.

The sulphur bacteria (*Beggiatoa*) form thread-like filaments in pools and ditches, where they oxidize hydrogen sulphide and with the energy thus released they extract the carbon from the atmosphere. The sulphur is left as a granular residue in the protoplasm of the cells. The iron bacteria (*Spirophyllum*) live in waters containing iron carbonates; by changing them from the ferrous to the ferric condition they get sufficient energy for forming protoplasm. Other bacteria subsist on manganese or selenium compounds.

Most important of the bacteria that are able to oxidize non-carbon compounds are the nitrite and nitrate bacteria. Whenever plant and animal remains decay, they produce large amounts of ammonia. The nitrite bacteria in the soil (*Nitrosomonas*) use the ammonia as a source of energy, oxidizing it into nitrites which really are a waste product of the bacterial metabolism. Other bacteria known as the nitrate bacteria (*Nitrobacter*) utilize these nitrites, in turn, as their special source of energy. After oxidizing them, they leave nitrates as a product.

In all of these cases, the bacteria have secured their energy for living from inorganic materials in their environment. By far the majority of the bacteria, however, have come to depend upon organic material both as a source of energy and of carbon. These are saprophytes or parasites, thus classified according to whether they live upon dead protoplasm, or upon that of living plants and animals.

The nitrogen-fixing bacteria (*Azotobacter*, *Rhizobium*) use other organisms as a source of carbon and energy. But they are unique in being able to extract the nitrogen they need from the vast reserves found in the atmosphere, whereas green plants can usually obtain their nitrogen only from the nitrates in the soil. Some of these nitrogen-fixing bacteria invade the roots of such plants as clover, peas, and alfalfa, establishing small colonies which assume the form of swellings on the roots. The result is a condition known as symbiosis, in which two different organisms live together for mutual benefit. The bacteria gain the organic material from the green plant, while the extra nitrogenous compounds elaborated by the bacteria are utilized by the green plant for increased growth. Such leguminous plants therefore increase the fertility of the soil by adding nitrogen to it in the form of usable nitrates.

Decay is not an inevitable phenomenon which takes place automatically in the living world. It is brought about by bacterial activity. Decay and decomposition are a most necessary link in the conservation of matter and energy; for without it all the bulk of past generations of plants and animals would still be with us, containing vast reserves of life-building elements, in unavailable form.

Every generation grows in size by the constant increase in protoplasm. This means taking carbon and nitrogen, among other elements, from the air and the soil. As living organisms increase in numbers, and grow to mature size, more and more of these two elements are withdrawn from circulation. Fundamental to the whole protoplasm building process is the work of plants in synthesizing carbohydrate and pro-

tein foods. Animals eat the plants, and thus the carbon and nitrogen compounds of the plants become transformed into animal protoplasm. It is self-evident that without replacement eventually *all* the available carbon dioxide would be removed from the atmosphere and locked up in the bodies of plants and animals, living and dead; and similarly the nitrogen supply would soon be exhausted in the soil.

Only a small portion of the atmosphere is carbon dioxide,—some 0.03 per cent. That is about 5.84 tons of carbon over each acre of the earth's surface. A crop of sugar cane consumes 20 tons of carbon per acre in one season. At the average plant consumption rate, in thirty-five years all of the carbon dioxide in the world would be used up.

So we face the conclusion that, were there no replacement of the carbon and nitrogen, life would have come to a standstill millions of years ago, due to lack of the two essential elements needed as raw materials for building living material. Small amounts of carbon are returned to the atmosphere during plant and animal respiration and by combustion of fuels. But this is in such relatively minute quantities that life would eventually come to a standstill even under these conditions.

It is at this point that the important role of bacteria in nature becomes evident.

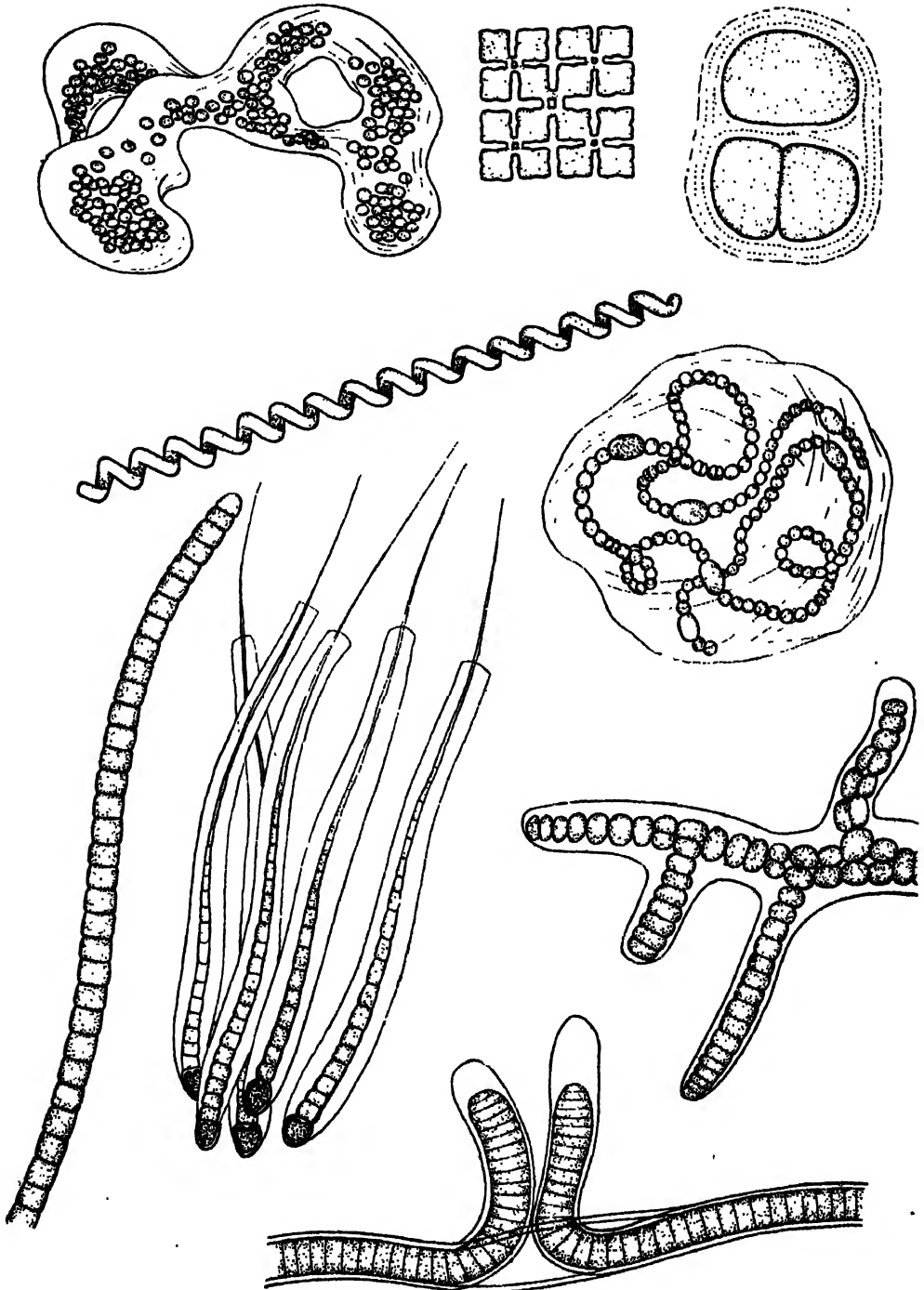
Many universally distributed bacteria which depend upon organic material for energy set to work upon plant and animal tissue as soon as life leaves them. Not only are the remains expeditiously removed from sight, thus making room for succeeding generations (a little appreciated but necessary scavenging service), but the complex organic compounds built up into protoplasm are reduced again to simpler substances and returned to circulation as available carbon and nitrogen.

Wood is a product extensively elaborated by plants. There are many wood-digesting bacteria capable of changing the cellulose (wood) into various intermediate compounds such as glucose and organic acids, and finally into carbon dioxide and water. This is done by bacterial enzymes similar in their activities to the digestive enzymes in our intestinal tract. Thus the carbon is returned to the atmosphere from which it originally came and where it is now available to be used over again by green plants in building new protoplasm. There is also a breaking down of proteins as well as carbohydrates in the decay process. Bacteria attack the huge protein molecules and eventually change them to ammonia. Then the nitrite and nitrate bacteria already described, change the ammonia into the nitrates which can be absorbed by the roots of green plants and used again to build proteins.

This importance of bacteria in keeping the elements essential for life in circulation can not be over emphasized. Were it not for the multitude of these invisible colorless plants, all life on earth would cease since there would be a continual withdrawal of the carbon and nitrogen, with their conversion into "frozen assets" as bodies of dead plants and animals. In bringing about decomposition, bacteria make it possible to continuously re-incarnate a living world from the remains of the dead. They are the despositors in the cosmic bank account while all other forms of life are reckless spenders who would soon reduce the account to zero.

But bacteria are useful in other ways, too. Many bacteria are utilized in various industries. They bring about the retting of flax in the making of linen; the conversion of milk substances into various cheeses; *Bacterium aceti* changes apple juice, or cider, into vinegar; while another bacterium acts on tobacco leaves to cure them. Some





CYANOPHYCEAE

Upper Row: Microcystis, Tetrapedia, Chroococcus.

Center: Spirulina, Nostoc.

Bottom Row: Oscillatoria, Rivularia, Stigonema, Scytonema (lower right).

aquatic bacteria (*Photobacterium*) present in sea water cause a luminescence similar to the so-called phosphorescence of various marine animals.

DISEASE-PRODUCING BACTERIA

Many of the bacteria thus far considered have been saprophytic species living on humus or decaying organic residues. There are also the numerous parasitic species living within the tissues of other organisms, some of which cause diseased conditions in the tissues of the host. It is these pathogenic bacteria that have given a notorious reputation to the whole group.

All three types of bacteria have such disease-producing species. The bacilli are responsible for tuberculosis, typhoid fever, leprosy, diphtheria and tetanus. The slender rods of the tuberculosis bacillus gain entrance into animal bodies through the respiratory and intestinal tracts, migrating to various organs and tissues where the bacterial colonies form masses of hard, gray translucent tissue. These nodules, or tubercles, give the disease its name. Tuberculosis bacilli are among the most widely distributed of the pathogenic bacteria; nearly every kind of animal is susceptible to their inroads. They have been found in many different mammals, cattle and swine being especially susceptible, and in fishes, amphibians and reptiles. Leprosy bacilli are similar in appearance, but differ in being restricted to the human species. Diphtheria is the result of small, slightly curved, bacilli which produce powerful toxins which poison the body. Tetanus bacilli are widely distributed in soil and in water; wood soils have been found to contain fewer of these bacilli than soils from gardens, streets and pastures.

The spirillum type is of less importance in causing diseases than either of the other two. Cholera is the result of a spirillum infection. Under natural conditions this disease is rarely found in animals. The spirillum, in addition to producing fatal toxins, is able to dissolve and destroy red blood corpuscles.

Cocci are responsible for a variety of abscess and pus-forming conditions in the human body, as well as gonorrhea, pneumonia, scarlet fever and osteomyelitis. Pneumonia cocci occur in pairs and are known as diplococci; they are pathogenic to various small animals (mice and rabbits) and to man. When the bacteria gain access to lung tissue, they cause lesions which make normal lung functions impossible. Pneumococci also cause peritonitis, eye infections, pleurisy and meningitis. Chains of streptococci cause various infections and lesions in the throat and elsewhere. When the infection is in the skin or subcutaneous tissues, erysipelas results. Sore throats, diarrhea, dysentery, appendicitis and fatal septicemia have all been traced to streptococci.

Non-pathogenic bacteria are always present in and on various organs of the body. Over one hundred different varieties have been found normal to the human mouth cavity; these are mostly spirilla and cocci. Normally harmless, these cocci may invade the gums around the base of the teeth and cause abscesses; or entering the tonsils, cause tonsillitis. In the intestinal tract there are many transient forms taken in with the food, as well as a permanent population. The high acidity of the stomach juices and the rapid elimination of the stomach contents tend to keep the number of bacteria in the stomach low. Relatively few bacteria are found in the small intestine, in contrast to the number found in the large intestine. In the latter there are many bacilli, such as *bacillus coli* and *bacillus acidophilus*. The former is an asset to the human body be-

cause it aids in changing proteins into simpler substances; the acidophilus bacteria coagulate milk and form lactic acid, and ferment maltose.

Thus the bacteria are a widely distributed group of plants which, though characterized by rather uniform size and appearance, by simple structure and correspondingly simple activities, carries on a variety of important relationships which involve them with other living things. Of the several thousand known species, a small number gain access to other living organisms and steal an existence from them as parasites. But by far a greater number are free-living species which are continually attacking the enormous collective mass of plant and animal bodies that have survived their usefulness while yet locking up within themselves the vital elements needed for continuance of life. By taking to pieces the elaborate framework of past life, its physical basis is demolished and the building units of carbon and nitrogen are again made available for the life cycle. This most humble of all the groups of plants is indeed an essential link in the well-ordained cycle of energy in Nature whereby a constant supply of life-giving essentials seem designedly present for the world of the living, reclaimed from the realm of the dead.

THE BLUE-GREEN ALGAE

Close relatives of the bacteria are the Blue-green Algae, (*Cyanophyceae*)—most primitive of the plants containing chlorophyll in their protoplasm. They resemble the bacteria in their simple cell organization, in their unicellular and unspecialized multicellular bodies, and in their inability to reproduce other than by asexual means.

The name Blue-green Algae is given to them because a blue pigment, phycocyanin, is present with the chlorophyll, sometimes in such quantities that it obscures the green color and gives the plants a brownish or bluish-black tinge.

Some of these little-known plants are found in terrestrial habitats, forming slimy coats on mud and sand and dripping rocks, or encrustations on stones and wood. Some, with the bacteria, constitute the subterranean flora. But a large majority are aquatic plants, found floating or submerged and attached in ponds, lakes, swamps, streams and waterfalls.

Many a fisherman has been puzzled at the "bloom" which, appearing suddenly in late summer, often fills his favorite pond with a scum of bluish-green dust or with what seems to be chopped up fragments of grass stems. This choking of the water by a rapid increase in the numbers of various Blue-green Algae, ordinarily microscopic and invisible, pollutes water supplies by giving them objectionable tastes and odors. Undoubtedly it affects the fish life by allowing lessened gaseous exchange through the surface of the water with the atmosphere.

Since their natural food is the organic material found in stagnant waters, when Blue-green Algae grow luxuriantly it generally means that some sort of pollution is present. Under ordinary circumstances the water blooms are only obnoxious, but at times they may assume economic importance by the poisoning of livestock compelled to drink water containing them. In the West, horses, cattle, sheep and turkeys have died in great numbers along the shores of lakes where such species as *Microcystis*, *Aphanizomenon* and *Anabaena* have formed water-blooms. Studied in the laboratory, these plants were found to contain a poison which is toxic to such laboratory animals as rabbits and guinea pigs.

The visitor to Yellowstone National Park has seen another result of blue-green algal activity. These plants can live in the waters of hot springs, at a temperature of about 77 degrees Centigrade, they have been reported from certain Californian hot springs at temperatures close to the boiling point of water (97 degrees Centigrade). These waters are usually highly charged with calcium and magnesium salts, which are precipitated as insoluble carbonates by the action of the Blue-green Algae, usually some species of *Phormidium*. This deposited material, known as travertine, may accumulate at the rate of four millimeters per week. It forms terraces of brilliantly colored hues, due to the layers of algae living on the surface of the precipitated salts.

The colonial Blue-green Algae include a great number of free-floating and inconspicuous plants common in every pond and pool. They are spherical or irregularly-shaped masses in which the groups of cells are imbedded in a jelly.

Chroococcus is a typical plant of this group; it occurs as rounded colonies made up of simple spherical cells united in groups of two, four, eight and sometimes sixteen cells. *Gloeocapsa* is another simple colonial form, characterized by thicker and more conspicuous sheaths around the individual cells. *Microcystis* forms larger and more irregular colonies of hundreds of cells crowded together into free-floating gelatinous masses. An abundance of this species is one of the causes of water-bloom.

Filamentous Blue-green Algae are generally attached instead of free-floating. Each plant is made up of a filamentous body, consisting of rows of cells in delicate, thread-like strands.

Oscillatoria is a very common bluish plant of widespread occurrence, by the trained eye of the botanist it can be easily found on any moist rocky cliff, on damp soil, muddy river bank or the bottom of shallow ponds and pools. Masses of the plants appear to be plush-like coats, covering the substratum with a velvety blue-green integument. Each *Oscillatoria* plant is an unbranched filament, capable of a slow swaying movement, usually at the tip, which has given the genus its name. A relative of *Oscillatoria* is the *Phormidium* plant, abundant in hot springs.

Nostoc is another common Blue-green Alga, differing from *Oscillatoria* in the presence of sheaths which are often confluent to form a gelatinous matrix in which the twisted, coiled filaments become entangled.

Scytonema is a filamentous Blue-green genus which has developed a method of false branching due to the segmentation of the plant into reproductive sections and the germination of these without their being freed from the sheath of the parent plant. *Scytonema* is found in various terrestrial habitats, on damp soil or on the face of dripping cliffs where the yellowish-brown filaments form an interwoven felty mass. A related genus, *Tolypothrix*, is more commonly found as blackish tufts, submerged on stones and twigs.

Stigonema represents the development of true branching filaments, often the main filament is several cells in thickness. It inhabits wet rocks and moist earth, where it forms yellow and brown, sometimes black, slimy cushions.

Most complex of all the Blue-green Algae is *Rivularia*, which consists of filaments tapering from a broad base to a fine hair-like tip, many of these filaments being united into very firm gelatinous colonies. Tufts of *Rivularia* colonies form brown and black

spots on submerged stones, stems and wood ; in some species the plants are encrusted with lime.

These plants are of additional interest because of their ancient genealogy. Their ancestors, very much like the living Blue-green Algae in structure and activities, are the earliest known fossil representatives of *any* kind of living thing. Fossil Blue-greens from the *Proterozoic Era form calcareous bodies similar to the "water-biscuits" resulting from such algal activity today.

* estimated to be at least 1,000,000,000 years ago.

CHAPTER II

The Simplest Green Plants



ANYONE who has inadvertently allowed his aquarium to remain in the sunlight, has become acquainted with these simplest of all green plants. The clear water gradually becomes clouded with minute green particles which cover the glass sides with a tenacious film ; these are microscopic green plants belonging to the Green Algae.

Likewise the fisherman who finds his hook caught in a submerged mass of twigs and branches brings up stems covered with tufts of slippery green threads. When torn loose from their anchorage at the bottom of a lake or pond, these silken masses form extensive floating mats of Green Algae commonly known as "pond scums". These plants also grow on rocks in streams, and on the brink of waterfalls, where they form graceful streamers. In the clear water of wells and springs many species form bushy growths on stones and woodwork.

Some species of Green Algae live on land where they form green coatings in damp places on soil, stones and bark of trees. Such a plant is *Protococcus* which has the unique distinction of being the commonest as well as the simplest green plant in the world. It occurs often as only a single cell, but at other times is found in small colonies of several cells. Each cell represents the green plant reduced to the lowest form possible.

In the pools left in rocky depressions by the receding tide, one can not help noticing the silky green strands of the algae which are common in such habitats and elsewhere about high tide mark. There are few natural landscapes more striking than a rocky pool filled with clear water, sides and bottom covered by beds of steel-blue mussels and colonies of white barnacles—and surrounding all, the swaying tufts of Green Algae.

In addition to these, there are countless hundreds of species which are as invisible as bacteria. A drop of water, under the microscope, reveals an unexpected world of floating and swimming plants, of surprising symmetry and beauty.

The basic character of green plants is found in the cells of which they are composed. Every cell, within its protective wall, contains a minute portion of protoplasm which may contain many differentiated substances. In some of the cells, scattered through the colorless protoplasm, are many small, usually oval, bodies which contain the chlorophyll. These chlorophyll-bearing bits of protoplasm are known as chloro-

plasts, and are found in all green plants. In the common flowering plants, every cell does not contain these chloroplasts; such green cells are restricted to special organs, particularly, the leaves. Thus it is in the leaves that food manufacture takes place. Other parts of the plant, made up of cells lacking chloroplasts, have other functions, such as the absorption of water by roots, the transportation of sap by stems.

In the Green Algae, however, as well as in all the other Algae, there is no such division of labor between the regions of food manufacture and regions carrying on other functions. The plant body is a thallus, undifferentiated into roots, stems and leaves. Usually, every cell of the Green Algae contains its own chloroplasts; this makes each cell more or less independent of its neighbors. Because the plants grow submerged in water which is rich in dissolved minerals, every cell absorbs what it needs for itself.

In the simplest Algae, the plant body is a single cell, as in *Protococcus*. But frequently the plant is a colony made up of hundreds of rather similar cells lacking division of labor into special tissues; or a filament of such cells making up a long thin thread. Most of the Green Algae are built up on this latter plan, a very successful type of plant body in an aquatic environment. A few species have experimented with other designs, such as the thin papery bodies or the cylindrical spongy ones of the marine species.

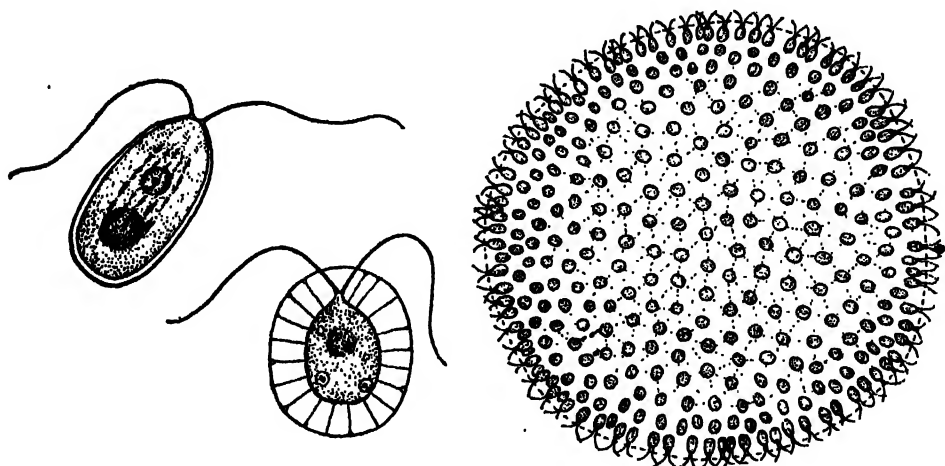
Division of labor in the land plants has further resulted in the setting aside of special reproductive organs,—the flower, fruit and seed. The Algae lack all of these; in fact, in many species there are no special organs for reproduction, each cell being capable of producing whatever reproductive bodies might be necessary. Many of the single-celled forms reproduce asexually by fission after the fashion of the bacteria. The many-celled species reproduce asexually by fragmentation, each fragment of the parent growing into a new plant; or by spores. A spore is a minute one-celled body which may be formed directly from a vegetative cell, or in special structures known as sporangia. The spores of many Algae have hair-like locomotor structures known as flagella or cilia; as a result these swimming spores, or zoospores, can actively move from place to place in the water. The spores of other Algae are immotile, a condition typical of such land thallus plants as the mushrooms. An algal cell can form zoospores simply by having the protoplasm withdraw from the cell wall, reorganize itself into a small unit which escapes from the cell, grows flagella, and swims away on a voyage of discovery. When it has exhausted itself it settles to the bottom of the pond, loses its flagella and then germinates into a new plant. In this way, dispersal of the Algae takes place.

The Algae also reproduce sexually by means of eggs and sperm. The eggs are relatively large, immotile cells formed in certain vegetative cells or in special egg-producing organs. The sperm cells are smaller and possess flagella, thus swimming in the same fashion as the zoospores. The sperm are produced in great quantities in vegetative cells or in special sperm producing organs. When released, the sperm swim through the water to the egg-cell or organ containing the egg, fuse with it, and the fertilized egg grows into a new plant. Such sexual reproduction by motile sperm, as in animals, is possible among the Algae because they live in the water. For terrestrial plants, such a type of reproduction is impractical, though it does occur to a limited extent among the mosses and ferns.

SWIMMING GREEN ALGAE

To many people a plant means a living thing anchored in the ground by roots and producing a branching stem bearing leaves. In actual fact, only about half of the known plant species have these characters; there are many plants without roots, stems and leaves. Among the Algae especially, we find thousands of species that confound the layman's idea of what an orthodox plant should be.

First of all, there are the plants which can swim about. These belong to a group of the Green Algae known technically as the Volvocales, in which the plants can move about in typical animal fashion. All being microscopic, they are unknown to few but the botanist. Fresh and salt water lakes, roadside ditches and pools of rain water are the usual haunts of these peculiar plants.



Motile CHLOROPHYTA (Green Algae)

Chlamydomonas, *Sphaerella*, *Volvox*.

The simplest of these is the one-celled plant known as *Chlamydomonas*, a pear-shaped organism with most of the cell filled by the large chloroplast. At the narrower extremity, two delicate flagella project beyond the cell wall and lash back and forth as the *Chlamydomonas* plant swims through the water.

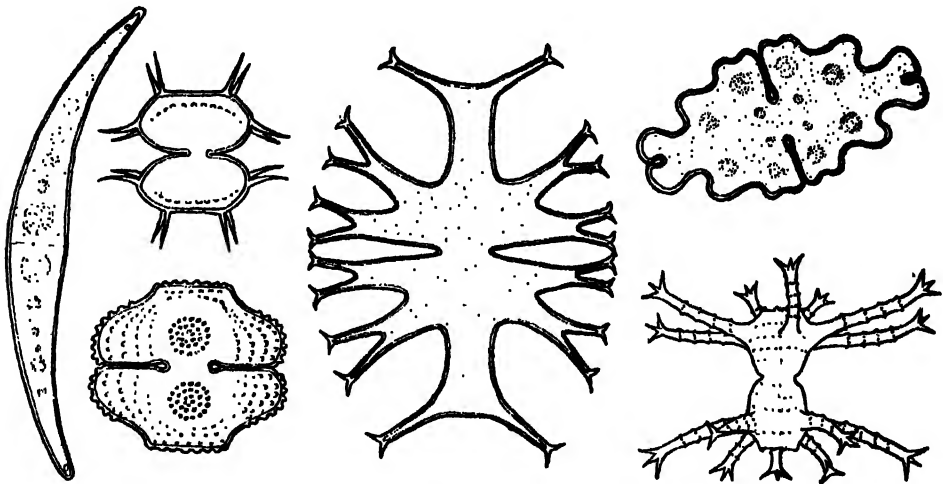
Similar in general appearance is another single-celled plant known as *Sphaerella*, a common genus of rain-water pools but found also on the surface of snow and ice. The green chloroplast is often completely obscured by red pigment, so that the plant appears red rather than green. Arctic explorers and mountaineers have often reported large areas covered with "red snow", a bloody and disconcerting sight to anyone but a botanist. For he knows that the "red snow" is in reality millions of *Sphaerella* plants forming a continuous covering over the chill substratum.

Other species of these swimming plants are made up of four to sixty-four cells, attached to each other in a gelatinous mass. In one species, the colony of cells forms a flattened plate, in another a spherical mass. The outermost cells retain their flagella and act as locomotor cells for the plant as a whole.

Largest of all is *Volvox*. This plant consists of a sphere of five hundred to forty thousand cells. The whole plant barely attains the size of a pin-head. A keen observer can see the green specks whirling their way through the water. Under the microscope, *Volvox* displays its hundreds of green cells symmetrically disposed about the periphery of the sphere, often connected with one another by thin strands of protoplasm. Each cell is so located that its flagella project outwards into the water; when these vibrate, the plant revolves through the water.

SINGLE-CELLED ALGAE

The single-celled type of plant body is very commonly met among the Algae. Some have flagella and therefore are motile; others, lacking such structures, drift passively, carried here and there by the water currents. Such drifting organisms are known as



Unicellular CHLOROPHYTA (Desmids)

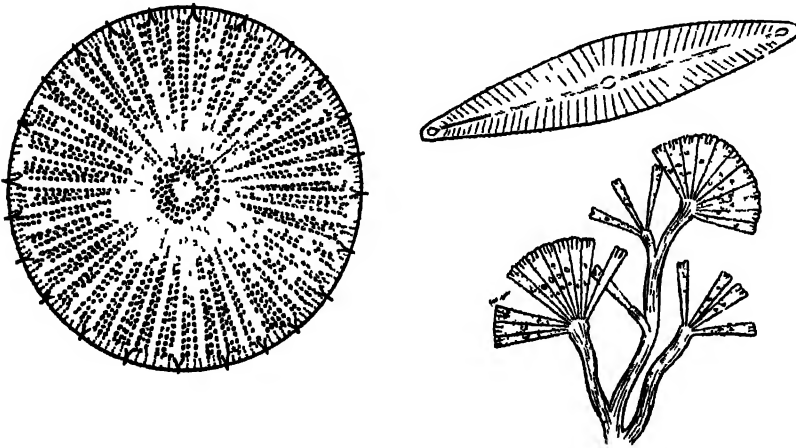
Closterium and *Xanthidium* (upper left); *Cosmarium* (lower left); *Micrasterias* (center); *Euastrum* (upper right); *Staurastrum* (lower right).

plankton, and constitute a vast invisible floating world in both lakes and oceans. Plankton plants make up the bulk of the marine vegetation, especially in polar regions. A fine-mesh drag net will yield a catch of plankton in the clearest reservoir or in the ocean waters a thousand miles from land.

Some of this plankton consists of Green Algae, many of which are spherical or cuboidal organisms without any special peculiarity. There is one group, however, which is worth noting since it rivals in symmetry and grace all other living creations. Some species remind one of the mathematical beauty of snowflakes. This group of microscopic Green Algae is known as the Desmids.

The Desmids are single-celled or colonial plants frequenting fresh waters. When some moss or other aquatic plant is removed from the water and squeezed over a jar, the collector has a greenish liquid which teems with Desmids. A plankton net will also yield samples of Desmids from any pond or lake. Most of the Desmids prefer the quiet waters of swamps and ponds; few are found in streams.

Cosmarium is a ubiquitous unicellular Desmid with a constriction in the middle, so that the plant apparently is made up of two cells. Each half may be kidney-shaped, oval or pear-shaped; the cell wall may be smooth or covered with an intricate design of dots and little knobs. The constricted median region of the body is characteristic of most Desmids. *Closterium* is another genus, characteristically long and slender, curved like a half moon, some species are incredibly long and thin, with colorless tapering extremities. Then there is the beautiful little *Euastrum*, its angular outline softened by sinuous curves and ornamented corners. In the genus *Staurastrum*, an end view of the plant discloses a triangular, rectangular or hexagonal outline; the cell walls are minutely but symmetrically sculptured and diversely ornamented, while the angles of the plant project in sharp spines. Spines are also characteristic of some other genera, one (*Xanthidium*) being so spiny that it is undoubtedly left alone as severely by hungry aquatic animals as cacti are by land animals. Most graceful of all is *Mutuas-*



Unicellular CHYRSOPHYTA (Diatoms)

Stephanodiscus, *Navicula* (upper right), *Lacinophora* (lower right)

terias (literally meaning "little star"), a thin flattened Desmid with circular outline, the margin indented and lobed in lacy fashion. Such Desmids are the aristocrats of the plankton, unfortunately doomed to everlasting lack of appreciation except by the microscopist. In no other group of the plant kingdom is there such elegance in abundance.

Another group of plankton plants belongs to a group of Algae known as the Golden-brown Algae (*Chrysophyta*), because of the yellowish cast to the cells. In some species this yellowish color completely obscures the green of the chlorophyll. This group is known as the Diatoms.

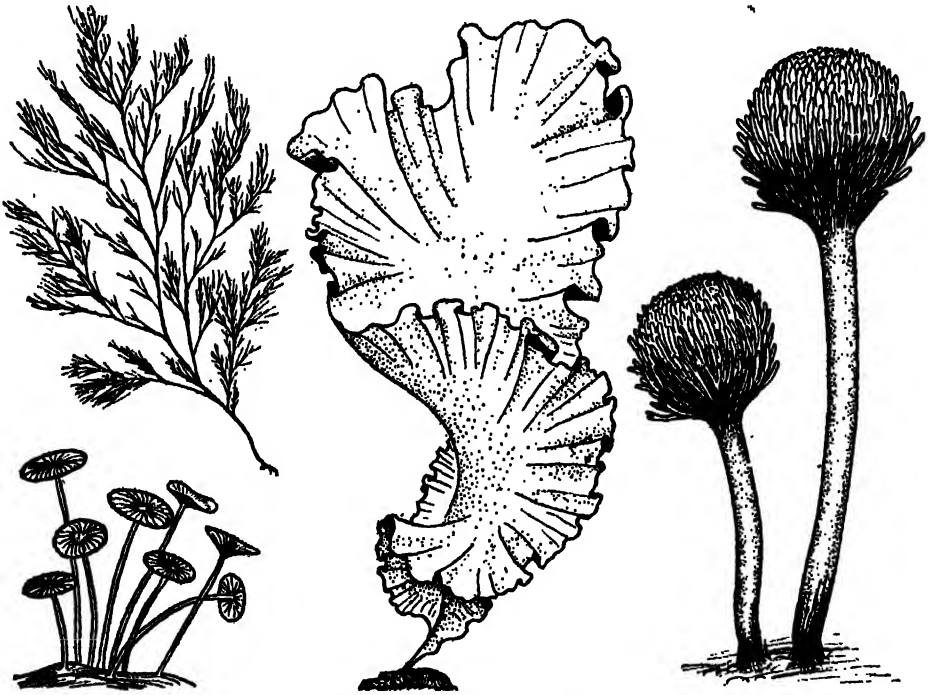
Diatoms are, like the Desmids, unicellular and colonial plants. They occur in the oceans as well as in lakes; sometimes they form yellowish gelatinous masses on moist soil and rocks. There are many more Diatoms than Desmids, one authority listing fifteen thousand species. Each Diatom cell is peculiar in that its cell wall is made of silica, and this siliceous wall is made in two halves, the one overlapping the other much as the cover slips over the other half of a pill-box. The wall is often sculptured



Caulerpa, a marine member of the Green Algae, is a moss-like plant found in tropical seas.

with delicate dots and lines in a complicated design. After the plant dies, this siliceous wall does not decay, but slowly settles to the bottom of the water where such accumulated sediments form diatomaceous earth. There are beds of such diatom deposits, now exposed on land, hundreds of feet in thickness. In the Lompoc area of California there is a bed seven hundred feet thick. Such diatomaceous earth is of considerable economic value, being used as an absorbent in high explosives, as a filter in sugar refining, as a heat insulator where ability to withstand temperatures higher than 1000 degrees is essential, and as a mild abrasive in polishes and tooth paste.

Some of the Diatom plants are circular single cells, as in the case of *Stephano-*

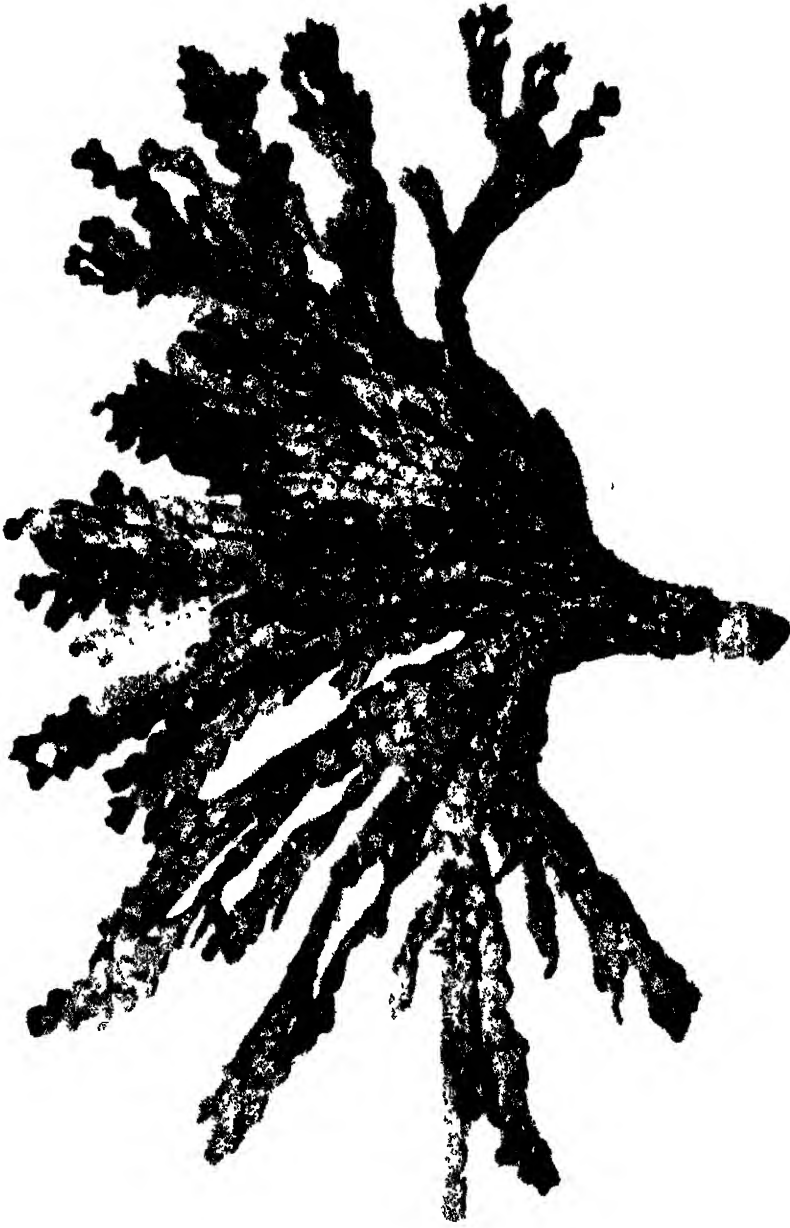


Marine CHLOROPHYTA (Green Algae)

Cladophora (upper left), *Acetabularia* (lower left), Sea Lettuce (center), *Penicillus*.

discus. Others are boat shaped, as in the appropriately named *Navicula*. This genus, in common with some others, can slowly move over the stem or debris on which it is living, because of a constant thread of protoplasm which streams along its under surface, forming an endless belt similar to the continuous tread of a caterpillar tractor. The result is a slow creeping movement peculiar to Diatoms.

Diatoms may have had an important part in the formation of petroleum deposits. One of the theories accounting for the origin of petroleum attributes the accumulation of this hydro-carbon material to the remains of dead diatoms. The plants sank to the bottom and became a part of the muddy sediments, so that when the muds were later transformed into shale, the organic hydro-carbon material of the diatom protoplasm



Halimeda, a marine coral-like plant belonging to the Green Algae, mimics the *Opuntia* Cactus with its stout stems divided into swollen segments

was squeezed out into the more porous sediments and rocks. The result is an underground reservoir of petroleum adjoining the shaly rocks.

FILAMENTOUS GREEN ALGAE

Most of the foregoing Green Algae and their relatives have been unfamiliar microscopic forms. There are also great numbers of pond-scums which frequently rise to to the surface and fill the ponds with slimy green masses. Most of these Green Algae are filamentous plants growing indefinitely at the apex; a few have a differentiated basal end, specialized for attachment to the substratum. When these filaments break in the middle, each half keeps on living and growing.

Typical of the filamentous type which is unbranched is a common pond-scum known as *Spirogyra*, abundant in ponds and ditches in spring and early summer. Its silky green filament observed under the microscope reveals a long row of cells, each with only a few chloroplasts spiraling around the outside of the cell much as a ribbon can be wound around a drinking glass.

There are many branching Green Algae. On turf or stones over which water flows there may be a felty interwoven mass of filaments of *Vaucheria*, unusual in that the filaments are really single cells, no cross cell walls being present. Likewise growing on stones and submerged sticks of rivulets and streams can be found the gelatinous bright-green streamers of *Stigeoclonium* and *Draparnaldia*. These plants under the microscope appear to be miniature counterparts of trees, with a central axial row of large cells from which grow out laterally smaller filaments, which in turn give rise to even smaller rows of green cells. The whole filamentous mass is often sheathed in a colorless jelly.

Hydrodictyon, or Water-net, is a genus with a rather unusual type of body. The cells are attached at their angles to one another, so that the colony consists of a network of cells with intervening spaces. Under favorable living conditions the Water-net plant soon completely fills up a pond; in lily ponds of parks, this alga has therefore come to be considered a pernicious weed.

THE GREEN SEaweEDS

It is in the oceans, however, that the Green Algae attain their greatest diversity of form. In temperate regions, the tidal pools and the sea bottom between tide marks are populated commonly by three kinds of Green Algae. *Cladophora* is a small tufted plant averaging less than six inches in length, made up of densely branching filaments. It is often called Mermaids Tresses. In tidal pools it forms a background of miniature bushes for the scurrying crabs. It also grows on the more exposed rocks at high tide mark. *Enteromorpha* is rather graphically described when one realizes that the two Greek words which form the basis of its name mean "intestine form". The irregularly cylindrical, often inflated, masses of light green float in the quiet waters of tidal pools and estuaries. In sheltered bays, the green fragments of *Enteromorpha* plants, torn loose from their foldfasts, may cover hundreds of square feet. *Ulva* is known as Sea Lettuce; it is a thin papery plant of a bright green color. The delicate fronds, a foot or two in length, are usually torn loose from the bottom and float in quiet inlets and coves.

Many unusual forms of Green Algae are found in the semi-tropical and tropical

waters, where these seaweeds reach their greatest luxuriance. Some of the species simulate so closely the external appearance of mosses and ferns that on casual sight the observer would fail to recognize them as Algae.

On tropical beaches the waves often toss up glistening spheres which look like glass globes. In reality they are the bodies of a green seaweed known as *Halicystis*, the entire globular plant being only a single cell. Some of the Bermuda species attain a size of three centimeters.

Caulerpa is a genus found in tropical seas, widely distributed in various countries. It reaches the size of many mosses and ferns, and develops a creeping rhizome-like axis which produces root-like hold-fasts; and erect shoots on the upper side resemble foliage branches. Some of the *Caulerpa* species look very much like the *Lycopodiums*, or Club-mosses.

Some of the tropical species extract lime salts from the sea water and deposit the lime in their bodies, which therefore become stony and calcified. These coral-like Green Algae have developed various types of bodies. *Halimeda* (named for one of the Nereids) mimics the *Opuntia* cactus in appearance, the closely packed filaments forming stout stems divided into swollen segments, each separated from the other by a narrow constriction. In the calm lagoons of the West Indies, *Halimeda* often forms entire banks and reefs. In the past, this genus may have been instrumental in building up the coral reefs of the Pacific. *Penicillus* is the Latin word for a small brush, certainly an appropriate name for this seaweed which has a stout whitish-green stalk terminated by tufts of stiff filaments, giving it the appearance of a shaving brush. It is common in Bermuda, the West Indies and Florida, where it prefers to grow on sandy and muddy shores. It has been found growing in such dense stands that the ocean bottom could not be seen; in the more open growths, the *Penicillus* plants look like miniature groves of landscaped evergreens. *Acetabularia*, a plant from tropical Atlantic waters, is perhaps the most unusual of all these calcified seaweeds. The name comes from the Latin word for little cup; perhaps to call this plant a little saucer would be more fitting. It has a delicate mushroom-like body, its slender stalk terminated by a flat circular expanse of radially arranged filaments which form a nodding cap to the frail white stem.

As is obvious from the sizes and shapes of these Green Algae, most of them live in sheltered and relatively shallow waters, able to survive only in such calm habitats. In this way they contrast decidedly with the massive kelps, other seaweeds which live where conditions are as strenuous as any known on land or in the sea.

These Green Algae and their relatives may seem to be of little economic importance. But the living species of Algae are vitally important as food for aquatic animals. Green Algae are the dominant vegetation of fresh waters, and are fairly abundant in the ocean as well. Fish are ultimately dependent upon such Algae for food; therefore there must be a certain amount of these inconspicuous and little known plants in any lake if fish are to thrive there. Thus, indirectly, these obscure plants are most essential in the food-chain which makes animal life of the waters possible.

Submarine Vegetation



THE vast areas of the oceans, constituting many times the amount of habitable land surface, shelter a variety of plants and animals as specifically adapted to aquatic existence as the more familiar land plants and animals are for a terrestrial life. In the depths of the ocean we find a world in many ways more novel and fascinating than the better known land world. Here is a realm of rainbow-hued sponges, of corals, sea anemones, mollusks, crustaceans and fishes, a mysterious domain where animals look like plants, and plants, in turn, assume shapes undreamed of by a land dweller. Beneath the surface of the water is a kingdom of black, brown, purple, red and lavender plants which, though leafless and rootless, attain unbelievable size and beauty.

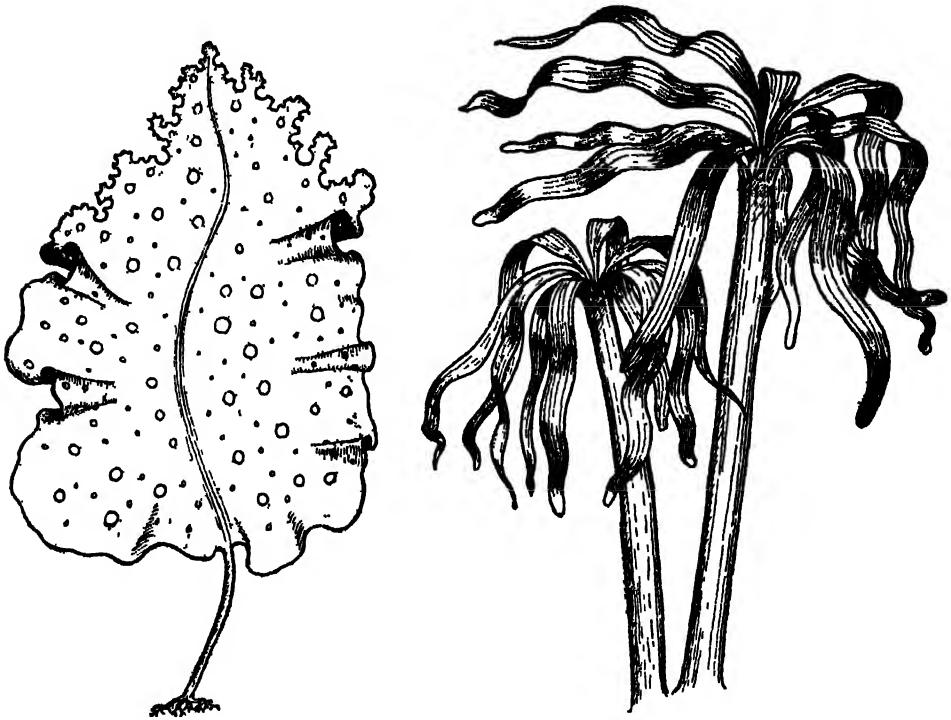
The plant life of fresh waters, as we have seen, is a mixture of invisible plankton organisms and simple filamentous plants belonging chiefly to the Green Algae. The ocean vegetation is likewise a mixture of plankton and attached forms of algal life, some Green Algae grow in the shore zone, and plankton Diatoms are in the upper reaches of all the oceans. But the submarine vegetation below low tide mark consists of different plants,—the Brown Algae and the Red Algae. Together, these two phyla make up the bulk of the marine flora, which extends from the low tide mark down to the lowermost reaches of light penetration. Further down than that, in the eternally dark zones of the deep sea, there is no plant life.

These marine Algae are plants which have lived for millions of years in a relatively constant environment, they have adapted themselves to the peculiar conditions associated with submarine living, and have colonized every available inch of ocean bottom as assiduously and successfully as flowering plants have done on land.

Living in the ocean presents certain definite advantages as well as corresponding limitations. Most characteristic of the ocean is the constancy of living conditions. Variations in the temperature in the open sea, even of the surface waters, are never more than fifteen degrees; and at some depth, it is practically constant. Nearly uniform, also, is the concentration of salts, presenting a medium rich in every element needed for living. This ample, continuously available supply of food allows not only the plants, but also the animals, to remain stationary, since the food will eventually come to the organism.

This lack of seasonal and daily temperature changes and the ever present supply of

water with the dissolved minerals essential for life make the ocean a paradise without much incentive for change on the part of its inhabitants, it seems to take a variable environment to bring about great evolutionary advances. It is a paradise wherein plants have not needed to develop root systems for absorption of nutrients, woody stems to support foliage organs, specialized leaves as regions for food manufacture. It is here that many botanists assume the first plants originated; though naturally the vegetation of the ocean today has changed considerably from its more primitive character, so that existing marine Algae can not be considered counterparts of the first forms of plant life.



PIIAEOPHYTA
Devil's Apron and Sea Palm

Yet every paradise has its drawbacks. In the uppermost zones of the ocean, adjacent to the coast, the action of waves and currents presents a combination so violent it would seem to discourage all forms of life. Watch the heaving and the crashing of the surf upon any rocky headland and imagine what stress the seaweeds must be capable of withstanding, to persist in such a habitat. Even in spite of this, the inter-tidal zone is one of the most densely populated of all the ocean areas.

Then there is the question of light. Sunlight, so essential for green plants, can penetrate but a short distance into the water. Thus the portion of ocean suitable for vegetation is only the upper four or five hundred feet. In the open seas, this illuminated zone is inhabited by the microscopic Diatoms. Where the ocean bottom is within this

limit, the attached vegetation forms submarine meadows and forests, varying in character of species, density of growth, with the varying condition of the bottom, the temperature of the water, and its depth.

Sandy or muddy bottoms form an insecure foothold, so here we find only the less massive species of the Green and Red Algae. Rocky bottoms offer better opportunities for the holdfasts of the larger Algae, such as the kelps. Given cool waters, rocky bottom and water of moderate depth, the giant kelps form veritable jungles of plant growth.

THE BROWN ALGAE

The Brown Algae, or Phaeophyta, are the dominant plants in those submarine zones close to low tide mark, extending to a depth of forty or fifty feet. A few of the Brown Algae live in the inter-tidal zone, where they form slippery growths of olive-brown Rockweeds. All of the plants in this group are characterized by a brown color, due to the pigment fuco-xanthin which usually so obscures the chlorophyll that the resulting color of the plant is some shade of olive-green, brown or black.

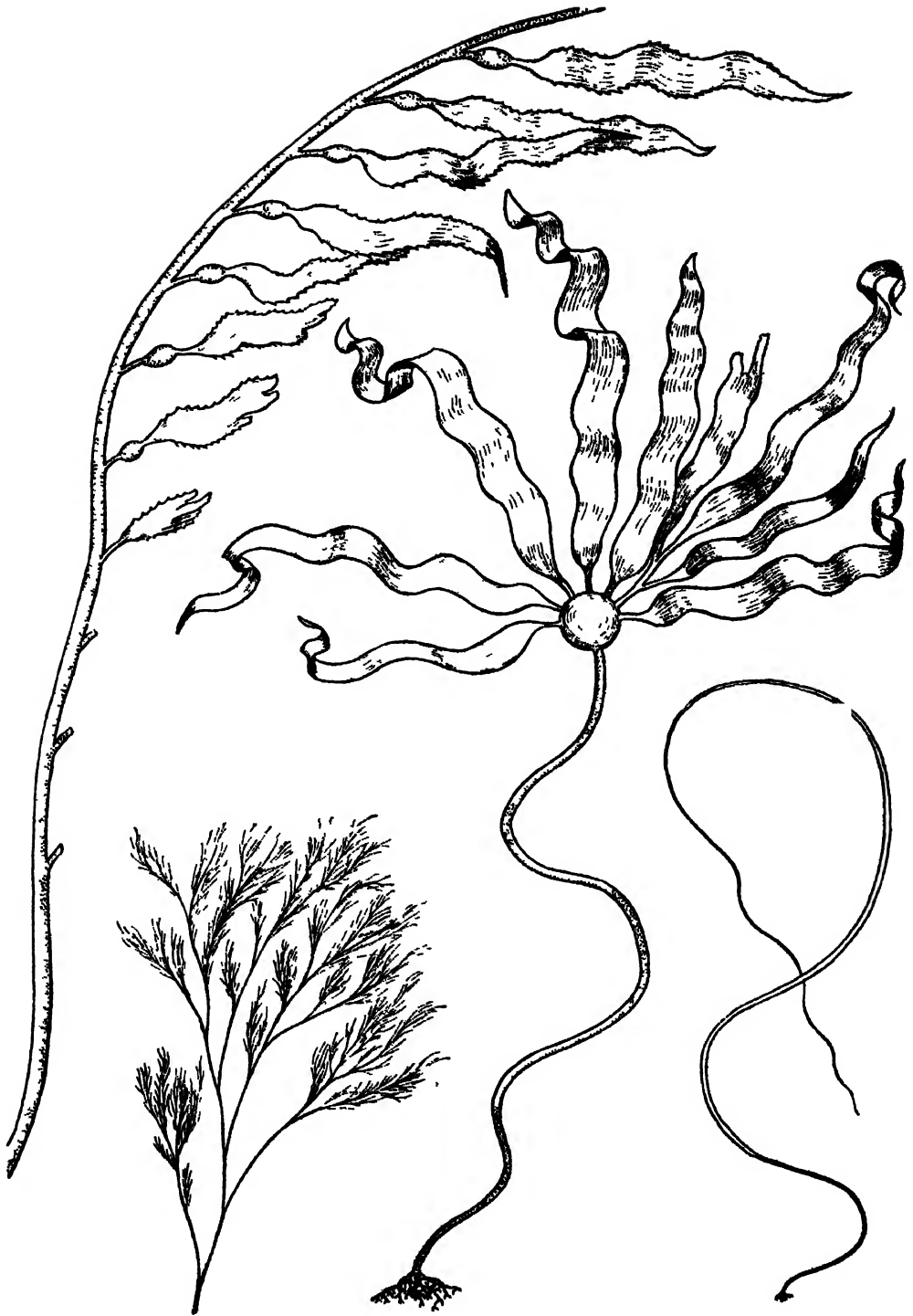
The term *Phaeophyceae*, sometimes applied to this group of Algae, is compounded of two Greek words; "phaios" meaning dusky or shadowy, and "phykos" meaning seaweed. It is appropriate to the dusky brown fronds of these plants, whose sinuous bodies can often be seen in the shadowy depths, continually moving with the currents.

The Brown Algae are the giants of the thallus world, a vigorous race which have colonized some of the most dangerous and inhospitable regions of the sea. Yet when aquatic plants migrated to the land, in the dim geologic past, these able species had to stay behind, chained to the marine habitat by their brown pigmentation,—an advantage in the dim sea water, but a handicap to living in the intense illumination of the land.

As the tide recedes, the spars and piles of wharves and channel markers begin to expose a shaggy coat of brown filamentous Algae, intermingled with the attached masses of barnacles, mussels and sea anemones. These silky streamers of golden brown are tufts of *Ectocarpus*, one of the simplest of the Phaeophyta. Its branched filaments cover objects in the inter-tidal zone with "Mermaid's Tresses" that resemble a *Cladophora* except for color.

Another filamentous type, somewhat coarser and more complex, is *Sphacelaria*; a seaweed which has become the staple food of the fishes and crustaceans of the Hawaiian Islands.

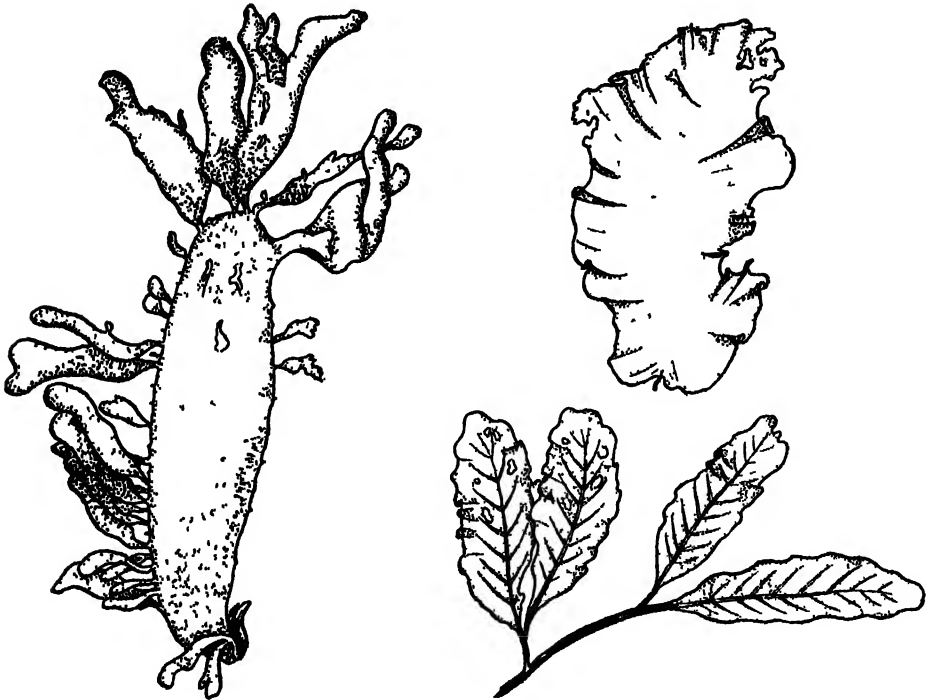
In other Phaeophyta the plant body is a gelatinous, globular or irregular mass; the Algae consisting of filaments packed together in thalli of a gelatinous consistency. When mature, the plant body frequently becomes hollow and breaks apart into expanded lobes. *Leathesia* is known as the Sea Potato because of its brown color and tuberous appearance. It is a widely distributed marine plant, found attached to rocks around low tide mark throughout the North Atlantic from the United States to Europe, and in the North Pacific from California to Japan. The soft, rounded "potatoes" are frequently washed up on the beaches after storms and very high tides. *Colpomenia* has earned for itself the name of Oyster Thief. It grows along our Pacific coast, on the eastern coast of Australia and the western coast of France. The hollow, papery plant attains the size of a tennis ball, growing attached to stones or oysters. Dr. Church



PHAEOPHYTA

Macrocystis (upper left), *Ectocarpus* (lower left), *Nereocystis* or Bladder Kelp, Devil's Shoelace (lower right).

describes the economic importance of this seaweed on the western coast of France: "the thallus of a parenchymatous organization is hollow and may attain the size of a hen's egg or tennis ball, as a 'balloon' On active photosynthesis in shallow water, the cavity so fills with internal gas bubbles that on the return of the tide the inflated balloons weigh the young oysters to which they are attached and float them out to sea. The number of oysters so carried off was so considerable that attempts were made to recapture them by nets, while faggots were dragged over the beds in the hope of tearing the thallus balloons."



RHODOPHYTA

Dulse, Laver (*upper right*), Delesseria (*lower right*)

More complex in structure than either of the preceding types of Phaeophyta are the Rockweeds and the Gulfweeds which form a conspicuous portion of the marine vegetation.

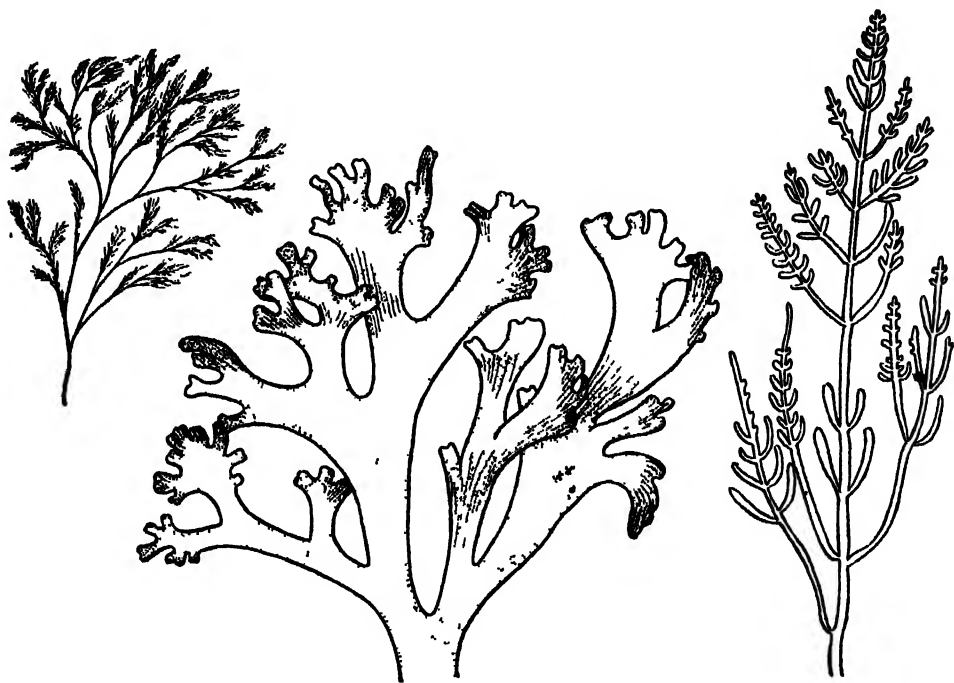
The Rockweed, also known as Bladderwrack, (*Fucus*) is one of the most universally distributed plants of the world. Attached to rocks, stones, shells and timber work between tide marks, *Fucus* plants cover acres of shore line with a dense mass of slippery, olive-green fronds. Swollen bladders grow along the forking thallus, which accounts for its common name of Bladderwrack. There is a branching, root-like holdfast which attaches the leathery little plant to the substratum, the fronds are flattened, and branch repeatedly by forking, attaining a length of several feet under most favorable growing conditions.



Rockweed or Bladderwrack (*Fucus*) is one of the most universally distributed plants of the world. Attached to the rocks, *Fucus* plants cover acres of shore line with a dense mass of slippery olive-green fronds. It is one of the Brown Algae.

Ascophyllum, near relative of *Fucus*, is another type of Rockweed, often growing closely intermingled with it. Its body consists of rounded branches, tougher than those of *Fucus* and with the swellings or air-chambers more conspicuous. When dry, Rockweeds turn almost black.

The Gulfweed, of notorious fame to mariners, is a brown seaweed, *Sargassum*, which gets its name from the Spanish "sargazo" meaning floating seaweed. Some 150 species of this plant are known, distributed generally throughout the oceans but most abundant off Australia and the warm seas of Japan. On our Atlantic coast it is found



RHODOPHYTA (Red Algae)

Polysiphonia, Irish Moss (center), Agar Seaweed.

from Cape Cod southward. Each plant, about the size of a small flowering plant, has a basal holdfast, a branching main stem with flattened leaf-like expansions which do most of the photosynthetic work and with other special branches bearing air-bladders resembling berries. The latter assist in keeping the plant afloat. Taken as a whole, *Sargassum* looks much more like a land plant than do any of the other seaweeds; but the resemblance is only superficial. Storms often sweep quantities of *Sargassum* out to sea, where the floating masses may accumulate as the ocean currents bring them together. It has been quite well proved, however, that the traditional Sargasso Sea of the South Atlantic is not primarily due to these seaweeds. In Japan, where *Sargassum* is common, the tender terminal tips of the plant are used as food by the Japanese fishermen. Devil's Shoelace (*Chorda*) is another common brown seaweed often found growing with Rockweeds about low tide mark. The gelatinous firm mass of crowded



Gulfweed (*Sargassum*) looks like a small flowering plant instead of a species of Brown Algae, the main "stem" has flattened leaf-like outgrowths and special berry-like air bladders which serve to keep the seaweed afloat.

filaments form a slender rope-like plant less than an inch in diameter yet frequently ten and twelve feet long. A submarine garden of these sinuous brown thongs, waving about as the sea water heaves up and down, seems less like vegetation than a wriggling mass of snakes.

The Kelps are the most massive and interesting of all the Brown Seaweeds; they are the Sequoias of the sea. The common Kelps of the north temperate regions include species of *Laminaria*, *Alaria* and *Agarum* (all found on our Atlantic coast); and species of *Postelsia*, *Nereocystis* and *Macrocystis* restricted to our Pacific coast, from Alaska to California. Kelps are especially abundant off the coast of Japan.

Laminaria is a term derived from the Latin "lamina" meaning blade or leaf, applied to this plant because of the broad flattened portion which terminates the stalk. It is a tough leathery plant, of a yellow-brown color, with a flexible stalk often many feet in length and a root-like holdfast at the basal portion while the terminal part looks like a greatly enlarged leaf. Kelps furnish concentrated and valuable minerals for fertilizers, tons being harvested for this purpose off the coast of Japan and Russia. These plants are rich in iodine, and are used as a source of this element. In Japan, where Kelps are a common article of the diet, goitre is unknown.

In Japan various foods known as "kombu" are made from Kelps, which are gathered in enormous quantities by fishermen during the summer months. After being dried on the beaches the Kelp is shipped to the "kombu" manufacturers who treat it in various ways. Some of it is dyed with Malachite green and shredded into shavings to be sold as "ao". These Kelp preparations have distinctive flavors for use as different portions of the meal; crisped over a fire, it becomes "hoira kimbu", coated with white or pink icing it is a sweetcake known as "kwashi", and pulverized it becomes a grayish flour. It is used as a vegetable with meats and soups, as a relish when boiled in soy-bean sauce, and as a beverage when shredded and dissolved. On our own Pacific coast, sugared Kelp stalks are sold as a candy. And recently a patent product made from Kelp has appeared on the market, providing the vitamins and minerals frequently lacking in land foods.

Agarum, commonly known as Devil's Apron, derives its name from the Malayan word agar-agar meaning edible seaweed. A short stout stalk spreads out to form an apron-like blade several feet in length and slightly less in breadth, coarse and torn, full of holes of varying sizes. It is an unkempt and tattered seaweed, seeming to tell of stormy days and violent living,—as indeed is true since this seaweed grows on exposed rocky headlands around low tide mark, subject to the pounding of tons of water as every wave breaks over it.

Alaria is well named, in that the Latin "ala" means wing; the broad leathery blade of this Kelp has at its base many small lateral leaflets which look like diminutive wings.

Postelsia, or Sea Palm, is small for a Kelp, rarely exceeding two feet in length. Palm-like in general habit, with a stout stalk terminated by a cluster of strap-shaped "leaves", this Kelp is the bravest of all the tribe, living where the environmental conditions are the most hazardous and violent. It grows only on rocks exposed to the action of heavy surf, and is admirably adapted for such a life. The hollow, elastic stalks bend horizontally under the battering of the waves, the stream-lined blades following the



Alaria is one of the Kelps (which are Brown Algae) with a broad leathery olive-brown blade and a basal cluster of small "leaflets", like all the Kelps, it is one of the most massive of marine plants.

lines of least resistance as the foaming waters rush by; then the plant resumes its vertical position as the water recedes, unharmed by the onslaught.

The largest and most conspicuous of the Kelps belong to the genera *Nereocystis* and *Macrocystis*. *Nereocystis* is fittingly named after Nereis, daughter of the sea god Neptune. The "cystis" portion of the name refers to the bladders which keep the expanded blades floating near the surface. It is known to sailors and fishermen as Bladder Kelp, Ribbon Kelp and Sea-otter's Calbage. The plant consists of a long slender stalk often seventy-five to a hundred feet long, terminating in a large spherical bladder which acts as a buoy for the circle of long thin "leaves" which grow from it. *Nereocystis* beds on the Pacific coast have been a valuable source of potash as well as fertilizer. About twenty five per cent of the dry weight of Kelp is potassium chloride, which at the outbreak of the World War was worth \$40 a ton.

Macrocystis, frequently attaining the great size of the *Nereocystis* plants, thrives on exposed rocky coasts, generally in water less than a hundred feet deep. Off the Cape of Good Hope it forms extensive banks of submarine forests, one hundred and thirty miles in width. It also is used commercially as a source of potash, but of more importance is its value as a corrective food for cattle, making good dietary deficiencies where land areas lack certain minerals, notably iodine.

At the Bureau of Fisheries exhibit at the Century of Progress Exposition, the value of these marine plants was emphasized by pointing out that "approximately 70% of the surface area of the world is ocean, which serves as a mixing bowl for the elements washed from the land. Marine plants and animals face no deficiencies and in time take these mineral elements and assimilate them into organic combinations which are needed by the inhabitants of the land to prevent or cure deficiency diseases." Sea-weed products contain iron, iodine, calcium, magnesium, sodium, phosphorus, potassium, manganese, aluminum, sulphur, copper, zinc, chlorine and vitamins A, B, D and E!

THE RED ALGAE

Farther down in the less-well lighted depths of the sea live the Red Algae (*Rhodophyta*). These red seaweeds have characteristically a red pigment known as phycoerythrin, which is associated with the chlorophyll. Because of this, the Red Algae can utilize the blue and violet rays of light which are the only rays left at the depths where these plants live. Green and Brown Algae, lacking this pigment, can not manufacture their food in such light. The red seaweeds assume every conceivable shade of red, purple, pink and violet. Living in a zone of continuous quiet, they reflect the peaceful conditions about them in the frail elegance of their bodies.

The *Rhodophyta* are also known scientifically as *Rhodophyceae*, the latter compounded from two Greek words,—"rhodon" meaning rose and "phykos" meaning seaweed. They are the diminutive citizens of the submarine flora, their delicately designed plant bodies usually less than a foot in length, forming undulating meadows and masses of shrubbery instead of forests, extending far down into the ocean depths away from the turmoil of the intertidal zone. It is in polar waters that they reach their most luxuriant size. A few genera have migrated into fresh water rivers, but by far the majority of the *Rhodophyta* are marine. Though more numerous as members of



The rich red *Dasya*, one of the Red Algae, is an elegant seaweed forming long sinuous growths which undulate gracefully in the ocean currents.

the submarine vegetation than the brown seaweeds, they are less conspicuous and more rarely encountered except after storms, when their twisted and battered remains are cast up on the beaches.

The plant may be simply unbranched filaments united by a gelatinous envelope—the most common form assumed by the Red Algae. Some species develop thin membrane-like expansions, but in practically no cases are there the massive leathery bodies typical of the Brown Algae. Since the Rhodophyta live in a calmer region of the sea bottom, far removed from the disturbances of ordinary storms and wave-action, they have no need of such well-built tissues. Instead they have developed frail bodies of nymph-like grace, varying in shades from dark purple to a most delicate pink or lavender.

The filamentous Red Algae show a great variety in the complexity of their main stems and in the types of branching. *Callithamnion* is typical of the filamentous varieties, a common seaweed of all temperate waters below low tide mark. The gracefulness of the silky red plants is summed up in the name, which is derived from two Greek words,—“kallos” meaning beauty and “thamnion” a small bush. *Dasya* is another elegant red seaweed, forming long sinuous growths rather than short bushy ones. The axial strand of cells is clothed with short hair-like branches giving the entire plant the appearance of chenille. In fact, the Greek word “dasya” means hairy. Large fronds may reach a length of several feet; they are very common from Cape Cod to the West Indies in this country. Another common filamentous genus is *Polysiphonia*. Where *Dasya* was a lake-red in color and *Callithamnion* a rose-red, *Polysiphonia* is usually a brownish red, verging on black. Like the other filamentous species, its bushy growths attach themselves to stones, shells and woodwork below low tide mark.

The membranous Red Algae have very thin and fragile tissues, much like paper, which are usually found torn into fragments by the waves. *Porphyra* (its name derived from the ancient word for a purple dye) has delicate fronds often but a single cell layer in thickness, and of a pale lavender or purple color. The elongate, strap-shaped thallus resembles an *Ulva* except for color, and in like fashion is found floating in torn and expanded masses. *Porphyra* grows in both hemispheres, from the polar waters of Greenland to the Mediterranean, from the Cape of Good Hope and Cape Horn to Australia and Tasmania. It is one of the seaweeds widely used as food. In England it is known as “laver”, in Ireland as “sloke”, and in Scotland as “slack”. In these countries it is boiled and eaten with lemon juice or seasoned with spices and butter. Welsh fishwives used to sell laver-bread; the seaweed product was also served as fried cakes with bacon. Among the Hawaiians it is a great delicacy known as “limu”, eaten fresh and crisp or salted and preserved. *Porphyra* grows abundantly in Japanese river estuaries, where it is frequently cultivated for the production of a favorite food, “amanori”. Some seventy thousand pounds of this is imported annually into Hawaii by Chinese grocers, with a retail value of twelve thousand dollars. In 1901 Japan had under cultivation over two thousand acres of *Porphyra* “fields” which yielded \$156 per acre—far from an unsatisfactory agricultural venture. Another of the flattened papery red seaweeds is *Grinnellia*, a distinctively American plant of our North Atlantic coast. It resembles a delicate parchment of brilliant red, with a wavy margin. Perhaps one of the most beautiful of the Red Algae is the leaf-like *Delesseria*,



Gelatina, a member of the Red Algae, is a flattened seaweed common to the tropics, growing by means of many leaf-like projections to form a rather coarse leathery frond.

which has a conspicuous midrib and venation resembling that of leafy plants. It looks for all the world like a bright red autumn leaf whirled into the crannies of the ocean bottom.

Rhodymenia is a flattened seaweed which is tougher than the preceding and branches irregularly to form a larger thallus. It is found on the North Atlantic coasts, as far south as the Mediterranean. This seaweed is also a common food plant in some parts of the world, used in the Atlantic regions much as *Porphyra* is in the Pacific. Dried fronds are said to have an odor like that of violets. Icelanders dry the fronds in the sun, pack them in casks and eat them raw, or boiled with milk and rye flour. In Norway the plant is called Sheep's-weed because the sheep are so fond of it that at low tide they explore every bit of exposed beach in a search for the brownish-red fronds. In Scotland it has long been known as dulse, and is used as a relish, is boiled with milk, has medicinal uses, and replaces chewing tobacco with the thrifty Scots. To the Irishman the same seaweed is known as dillisk, and is there likewise boiled with milk, eaten with butter and fish, and chewed as tobacco. In times of famine, dillisk and potatoes have formed the only food of many of the poorer people of the west coast of Ireland.

Chondrus is a more stubby little seaweed, the Greek word "chondrus" meaning cartilage being well put for the texture of the brownish-purple plant which grows on rocky shores about low tide mark. It is commonly known as Irish Moss, or Carrageen, and is one of the few seaweeds collected in the United States for commercial purposes. On the south shore of Massachusetts Bay fishermen rake up boatloads of the sea moss, bleach it by drying it in the sun until it becomes straw-colored, finally ship it to market in barrels. The resulting product has high gelatinizing qualities, 65% of the water-free seaweed being gelatinous matter. It is used in curing leather, in sizing cloth, as an ingredient of cosmetics, shoe polishes and shaving soaps. The Japanese use it for a shampoo to impart a gloss to the hair. The mucilaginous qualities of the alga make it valuable in various food dishes, being used both in Europe and America for jellies and puddings sometimes known as sea farina.

Another flattened leaf-like red seaweed known as *Dulsea* is said to have been the source of the rouge used by the women of Athens and Rome. In fact, the first general term for cosmetics to be used in England was "fucus", indicating some relationship between Algae and cosmetics. *Gigartina* is a rather massive flattened species common in the tropics. *Gelidium* is a red seaweed which has been for years a source of vegetable gelatine. *Gelidium* is a compressed, cylindrical plant, coarsely branched and of a reddish brown color. It is the chief source of the jelly known as agar, widely used in bacteriological work. Under the names agar, kanten, and Oriental Isinglass it has been used in the East for many centuries. In Japan, more than in any other nation, it is used as a food,—being made into jellies, soups, sauces and desserts.

Many of the species of Rhodophyta, as was the case among the Chlorophyta, are able to extract lime salts from the sea water. These coralline forms occur from the tropics to the cold polar waters. *Lithothamnion* is a rock-encrusting alga which forms a reddish expansion, looking much like a part of the rock itself. These are reef-building plants, in some oceanic areas as important in this respect as the corals. *Corallina* is a small bushy seaweed with pinkish-white jointed stems, heavily encrusted with lime.

The segmented stems are so fragile that they break into pieces when handled. It is common on our North Atlantic shores.

Such is the vegetation which makes up the home and furnishes the basic food supply of the marine animals; truly a strange world of plant life where the green tints are the exception rather than the rule, where brilliant reds and warm browns present meadows and forests more gay in color than a New England woodland in autumn—a world of plants without leaves, stems or roots yet with bodies as tall as elms and as sturdy as oaks, a flowerless realm made incredibly beautiful by the elegant and graceful forms of these bizarre sea plants.

CHAPTER IV

Mushrooms and other Fleshy Fungi



GREEN is the characteristic color of the plant kingdom, the emblem of the independence of plants over other living things. But there are some plants that have given up this color, have lost the green pigment through some biologic accident which has become perpetuated through heredity. In a few instances these non-green plants belong to the flowering plant phylum, as is true of Indian Pipes, Cancer Root, Coral Root, and some others. But in most cases they are thallus plants, developing a simple plant body without much tissue organization, reproducing by spores. Of these colorless thallus plants, the Bacteria are the simplest. The remaining species are included in the phylum of the Fungi, a large group of some 75,000 species at least.

The Fungi can be considered an assemblage of three related classes of plants,—the Algae-like Fungi or *Phycomycetes*, the Sac Fungi or *Ascomycetes*, and the Basidium Fungi or *Basidiomycetes*. The Mushrooms and their relatives are Basidiomycetes, with but few exceptions; it is this last group which forms the subject matter of this chapter.

All of the Fungi have certain definite characteristics in common. They are most closely related to the Algae, like them having simple bodies lacking true tissues and organs. Some of the Fungi are single-celled organisms (yeast), but the majority are characterized by a filamentous body. These filaments lack chloroplasts; thus it is impossible for the plants to manufacture their own food out of inorganic substances. The filaments must take in organic material as food from the environment, just as animals do. When this food consists of portions of living organisms, the fungus lives as a parasite. Many of the parasitic species belong to the Ascomycetes. More usually the food is organic material which once was a part of an animal or of a plant; when a fungus feeds in this fashion upon remains of living things it becomes a scavenger and is known as a saprophyte. Most of the mushrooms are saprophytes. It is the business of this filamentous "body" of a fungus to absorb this food in one way or another; sometimes the branching filaments form loose, cobwebby growths as in the common Bread Mold; at other times they form a compact mass, quite firm in texture and even woody in nature, as among the Mushrooms and Shelf Fungi.

Mushrooms, because of their absolute dependence upon an environment containing organic material, can live only in certain areas. A favorite habitat is the rich leaf mould of deep woods, the decaying leaves furnishing them with adequate nourish-

ment. They are common also on tree trunks, fallen logs and stumps, and all objects made of wood,—telegraph poles, fence posts and railroad ties. Few are found in pure sand, clay or loam since such a habitat furnishes too meager sustenance for the fungous appetite. In addition most of the species prefer damp locations. Sunlight and dryness are hostile to most fungous growth, since the filamentous bodies contain an unusually high percentage of water. Taken into the scorching heat of the sun, a mushroom shrivels up and loses its characteristic shape and color. This need for moisture is one reason for the abundance of mushrooms during rainy seasons.

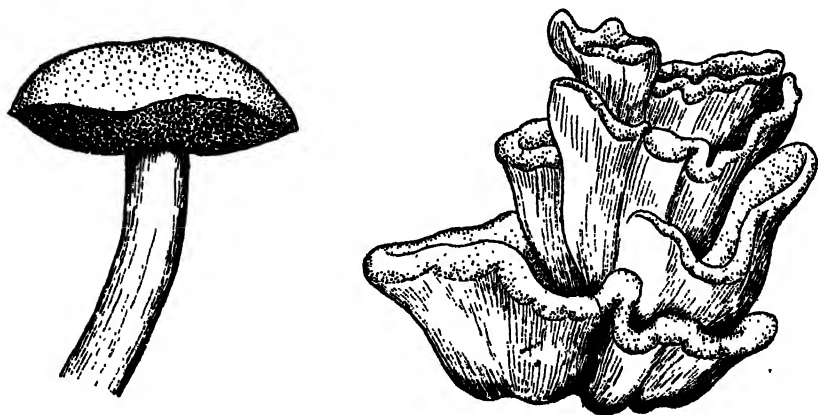


AGARICACEAE

False Chanterelle, Shaggy Mane, Parasol and Destroying Angel Mushrooms.

The filamentous vegetative body of the mushroom forms an interwoven mass of filaments in an underground felty structure known as a mycelium. This mycelium spreads throughout the nourishing substratum, whether that be bread, manure, shoe-leather or a tree trunk. Mushroom growers call this mycelium, spawn. It corresponds to the entire root-stem-leaf system of an ordinary land plant and is not just an absorptive root system. Stripping off the bark of a decaying log, one can often see these white mycelial threads spreading out in all directions through the wood. This mushroom vegetative body eventually reaches the reproductive phase of its life history. When it does, it produces the above-ground portions which alone are usually considered the mushrooms. Little knobs form on the mycelium, growing rapidly in size and soon projecting above the ground as mushroom "buttons". These globular objects increase in size at an astonishing rate, clusters of them often appearing overnight. If the fungus is one of the Puffball group, this spherical growth becomes the stemless brown sac with an opening at the top through which the spores, produced in

the interior, are released. If a typical mushroom, a stalk and cap become differentiated. At the base there is often a sac-like swelling through which the stem projects; this is known as a volva, and is an important earmark of some poisonous mushrooms. As the umbrella-like cap opens, a ring may be left around the stem indicating the former attachment of the rim of the cap; this "veil" is another distinguishing feature of many species. On the under side of the cap are the spore-producing tissues. In the Gill Fungi, these tissues form radiating partitions known as gills, on the sides of which the special spore-producing structures (basidia) are found. In the Pore Fungi, the spores are produced in little tubes which cover the under side of the cap with countless small holes or pores. When mature, the spores are carried by the wind to new localities; each spore can germinate into a new mycelium and thus repeat the life cycle.



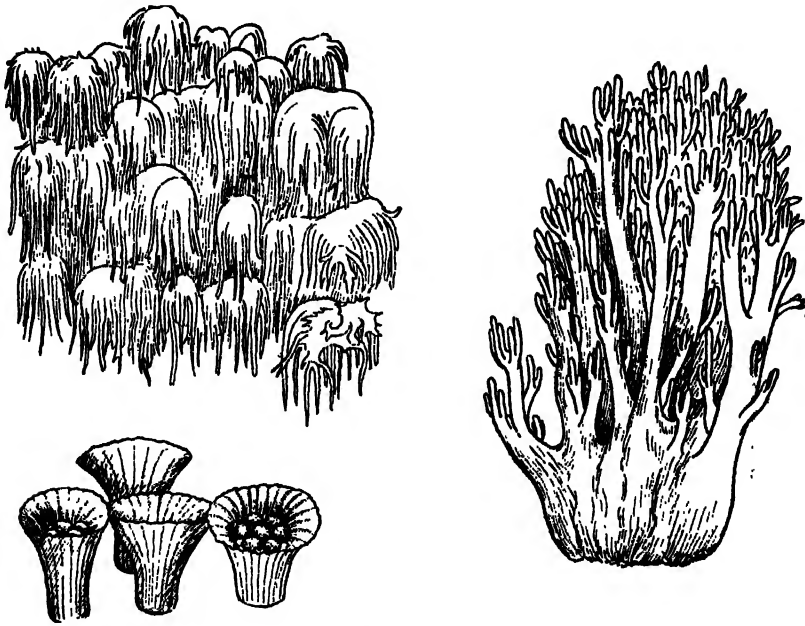
POLYPORACEAE

Boletus and *Polyporus*.

Mushrooms have had a varied appeal to mankind through the centuries. The Greeks and Romans thought highly of them, prized them as food delicacies. And down through the ages, various peoples have continued collecting and growing them for food. On the other hand, mushrooms have become objects of aversion to many people. The dismal places in which many of them grow, their slimy appearance (in some instances) and their lurid colors have given them an undeserved notoriety. The presence of poisons in some species has hardly added to their desirability. To such people, the loathsomeness of these plants is summed up in their term for them,—toadstools.

But apart from their edibility, mushrooms are interesting in their own right, and their acquaintance is worth cultivating. Mushrooms grow in a variety of colors, many of them unusual and striking; ordinarily white or tan colored, the cap may be deep red (*Russula*), bright orange (*Cantharellus*), indigo blue (*Cortinarius*), lavender (another *Cortinarius*), or smoky black (*Coprinus*). They also vary in texture from the satiny sheen of an *Amanita* to a velvety plush (*Lentinus*), with or without a coating of varicolored scales or bristles. Even the odors vary, from the unbearable smell of many common species to the almond-like sweetness of an *Agaricus*.

To those who like them, mushrooms are a great delicacy. The plants are eaten in a variety of ways,—stewed, baked, fried, boiled, creamed, and roasted. They are even made into pickles, soups, fritters and catsup. Most of these are bought from mushroom growers who raise their plants on carefully prepared beds in cellars, caves and abandoned ice houses. This is by far the safest method of securing mushrooms, for eating the wild species is a rather dangerous practice for the amateur botanist. There are over two hundred edible wild species, but the uninitiated is likely to confuse some of these with the two dozen or more poisonous forms which unfortunately are also common. The most familiar edible species are found among the Puffballs, Morels, Chanterelles, *Boletus* (also known as Cèpes), Beef-steak Mushrooms, Chicken Mushrooms, Milky Mushrooms, and the common Field Mushroom.



HYDNACEAE, NIDULARIACEAE AND CLAVARIACEAE

Bear's Head Mushrooms; Bird's Nest Fungus (lower left); Club Fungus (right).

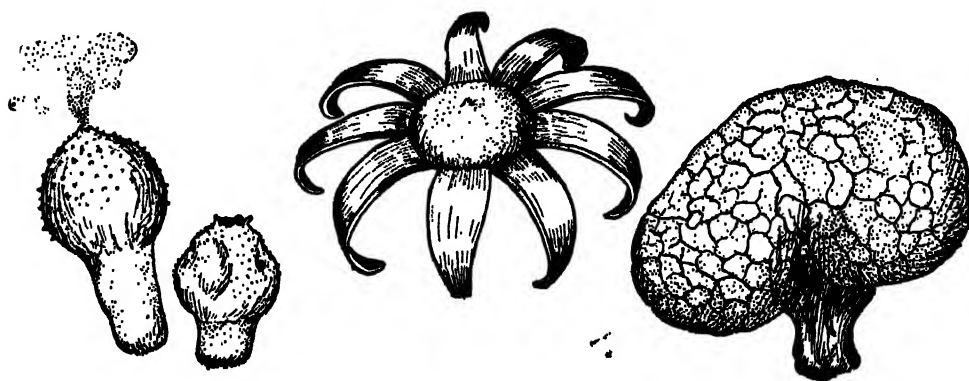
Of the poisonous species, there are the deadly *Amanitas* and certain species of *Russula*, *Gyromitra*, *Volvaria*, *Inocybe*, *Pholiota*, *Clitocybe*, and *Panaeolus*. Some of the poisons, as the muscarin found in *Inocybe*, cause gastro-intestinal upsets and nervous disability which may end in convulsions, delirium and death. A successful antidote for this type of mushroom poisoning is atropin. The poison in many cases (*Panaeolus*, *Amanita*) is not fatal, causing only either stomach upset and nausea or temporary intoxication. Some *Amanitas* are the most deadly of all mushrooms, so deadly that there are records of children dying from eating but a fragment of the cap. The poison is especially dangerous since symptoms rarely appear until the deadly toxin has all but completed its lethal work. Violent abdominal pains, vomiting, a livid face, mark

the early stages in poisoning; these are followed by jaundice, coma and—often—death.

THE GILL FUNGI

The true Mushrooms, as has already been stated, are for the most part a family of *Basidiomycetes* known as the Gill Fungi or *Agaricaceae*. The usual method of classifying the various Gill Fungi is by the color of the spores, which may be either black, rust-colored, brown, purple, yellow, rose, pink or white.

Some of the black-spored mushrooms belong to the genus *Coprinus*, known as the Inky-caps. When the spores ripen, the gills dissolve to form an inky fluid. The cylindrical or barrel-shaped brown cap does not expand until the gills begin dripping



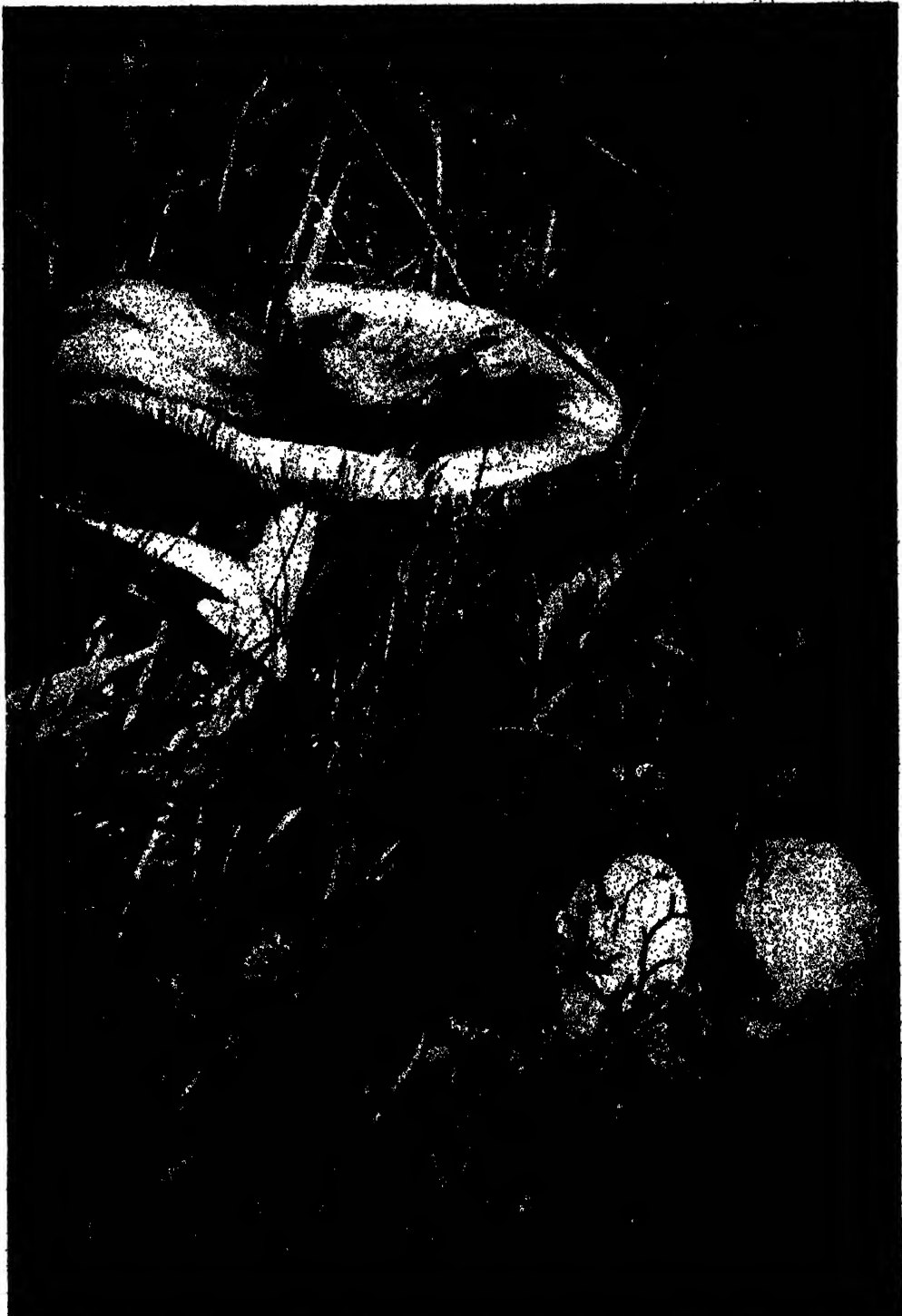
LYCOPERDACEAE

Common Puffball, Earth Star, Brain Puffball.

their black spore masses. These appear in the rich soil of gardens, roadsides and woods in late summer. The Shaggy Mane is a species with yellowish scales on its cap. Another species, the Glistening *Coprinus*, springs up in dense clusters on grassy ground around old stumps.

Rust-colored spores are found in several genera. *Cortinarius* includes many species, most of them inhabiting woods and thickets where they appear late in summer. The cap, which grows to a diameter of five inches, atop a stem often six inches high, may be brick red, yellowish brown, lavender or golden yellow. All are edible. The *Pholiotas* generally have a yellowish cap, sometimes covered with scales. They are common on tree stumps, in mossy swamps, and even on rocky or grassy ground. The cap averages four inches in breadth, on a stem half that height. One species, the Autumn *Pholiota*, is poisonous; the others are edible.

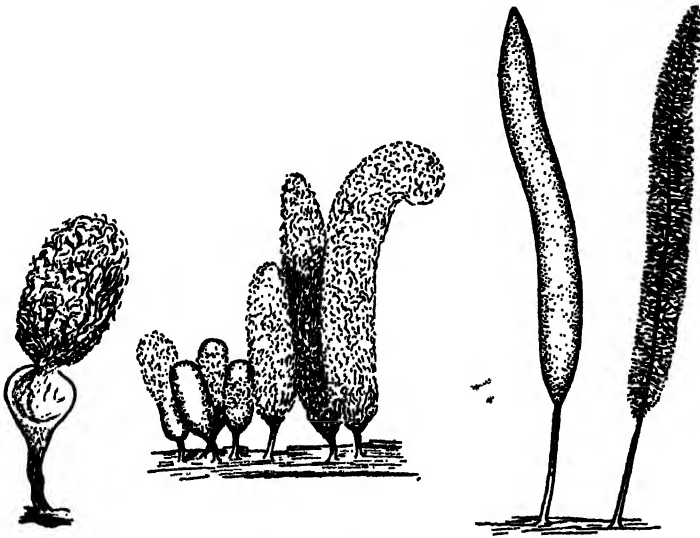
Among the brown-spored species we find the common Field Mushroom (*Agaricus*). The white or tan-brown cap, often five inches or more in diameter, has a silky luster. It rarely grows in the woods, preferring the open fields and pastures where it matures late in summer or early in autumn. Also brown-spored is the edible *Psilocybe* or Haymaker's Mushroom common in early summer on lawns and other grassy places. The small cap (less than an inch in diameter) is smooth and reddish-brown, borne



The Field Mushroom (*Agaricus*) prefers open fields and pastures where it displays its tan-brown cap, which often has a silky luster.

on a thin stem rarely more than two inches high. Similar to this in many respects is *Hypholoma*, a yellowish-white capped species common around the base of stumps and old trees.

The yellow spored species include the inedible *Inocybe*—rather small gray-white mushrooms less than an inch in size, found among mosses in woods. Slightly larger is the genus *Hebeloma*, like *Inocybe* except for the moist sticky cap; it is one of the few mushrooms which tolerate open sandy habitats. *Craterellus*, known as the False Chanterelle, is small and trumpet-shaped, quite inconspicuous in the copses it frequents because of its sombre yellowish color. The center of the cap is depressed,



MYXOMYCETES

Slime Mold *Arcyria* (two left hand figures) ; *Stemonitis* (right).

showing the wrinkled under surface which lacks true gills. Another common yellow-spored mushroom is *Gyromitra*, peculiar in the lobed and irregularly folded surface of the cap, which in some ways resembles the Morel Mushroom. The color varies in the different species, from brown to red. The species known as False Morel, though considered edible by some authorities, has caused the death of many eaters. *Gyromitras* prefer wet ravines and rich woods.

The spores of the common *Pluteus* are rosy-pink, as are those of *Volvaria*. The Fawn-colored *Pluteus* is an edible species with a grayish white cap, about four inches in diameter. It can be found in any locality providing an abundance of decaying wood; it often grows on sawdust piles in old ice houses. With the increasing difficulty in getting horse manure for cultivation of Field Mushrooms, this sawdust-inhabiting species may attain greater economic importance. *Volvaria* grows singly in wounds of the bark of deciduous trees, preferably maples. It is a large mushroom, its white silky-scaled cap often measuring eight inches in diameter.

The white-spored mushrooms include a great number of common species. Num-



The Fly Mushroom (*Amanita*) flaunts a widespread orange cap, dotted with white or yellow warts; it is a man-killer, far prettier to look at than desirable to eat.

ber one on the list is the most dangerous man-killer of all the Fungi, the genus *Amanita*. The Fly Mushroom flaunts its widespread orange cap, dotted with white or yellow warts, in open woods and overgrown pastures. The Fly Mushroom grows to a height of eight inches, and is truly an arresting sight—but it is far wiser for one to look at it than to eat it. Its poisonous properties have already been noted; but even with this record, *Amanitas* are made into a beverage by Siberian tribesmen, who use it in place of the alcoholic beverages common to civilized man. During local celebrations, a whole village will go on an *Amanita* spree, the intoxicated drinkers temporarily exhilarated but not fatally affected by the juice. The Destroying Angel is also poisonous; in appearance it is a tall, ghostly white mushroom sometimes tinted with gray or brown, common to woods and thickets. *Amanitas* have the swollen bag at the base (volva) which is often referred to as a "death cup" and used as a means of identifying this dangerous plant.

Then there are the other white-spored genera which include the Honey Mushroom, the Chantrelle, *Clitocybe*, *Collybia*, the Milky Mushroom, *Lentinus*, the Parasol Mushroom, the Fairy-ring Mushroom, the Oyster Mushroom and the *Russulas*.

The Honey Mushroom (*Armillaria*) grows sometimes on the ground, more commonly on the decaying wood of trees. It is one of the commonest Mushrooms, and is edible as well. Unfortunately, it is also one of the worst offenders in causing the rot and death of trees. The cap, white or yellow with numerous dark brown scales, ranges in size from one to six inches, and is borne on a short stout stem. When the mycelium is torn from rotting logs, at night, it gleams with a ghostly blue light known as Fox-fire. The light is due to the luminescent properties of the mycelium.

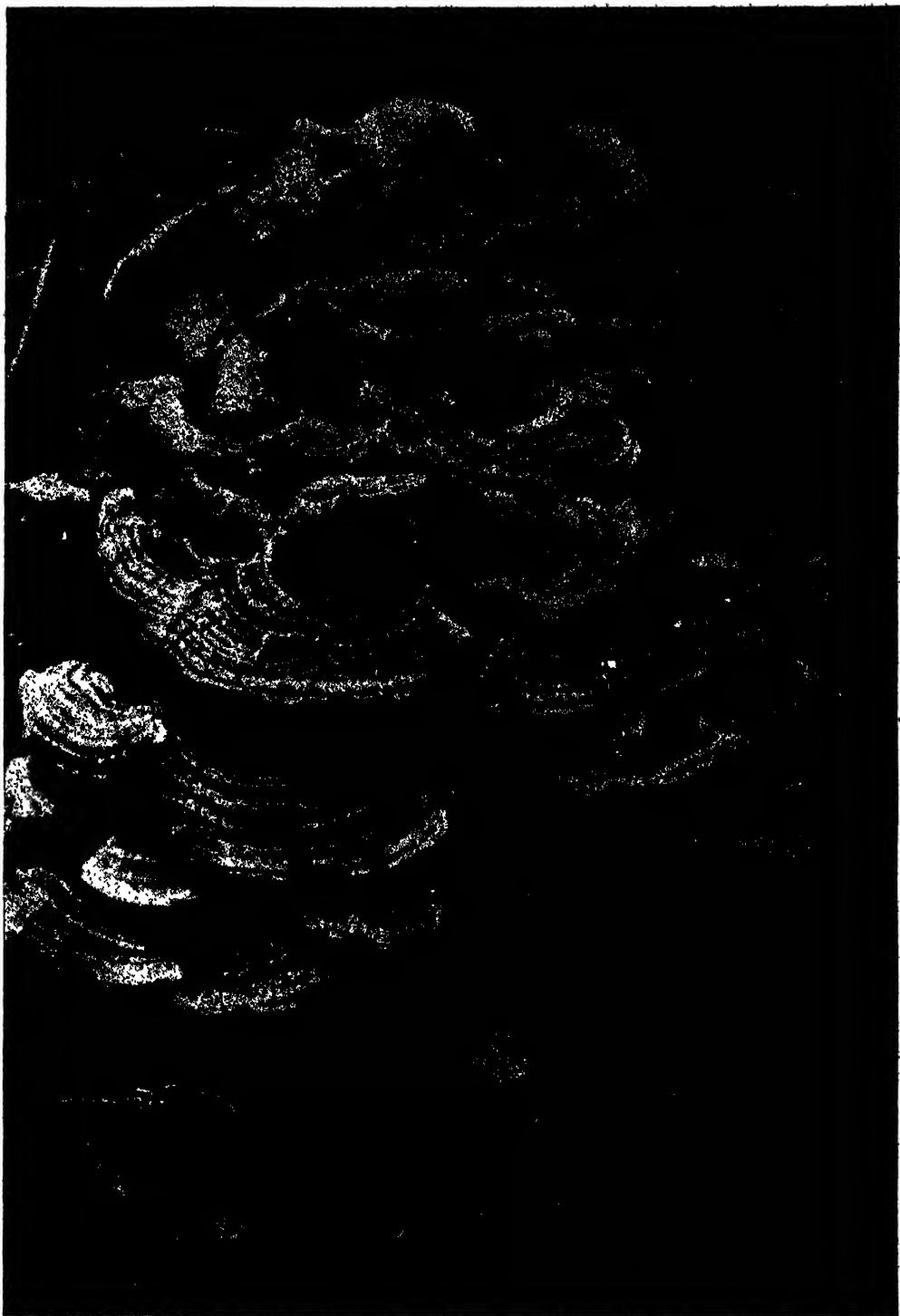
The brilliantly colored yellow or orange funnel-shaped caps of the Chantrelle (*Cantharellus*) are conspicuous objects in the shaded woody spots in which they are commonly found. The gills, exposed by the depressed shape of the cap, fork and branch irregularly, noticeably different from the radial arrangement in the other *Agaricaceae*. One species is considered the choicest of tid-bits by European mushroom connoisseurs.

Clitocybe includes a species quite similar to the Chantrelle, known as the Jack-o-Lantern Mushroom. The yellow caps are rarely as funnel-shaped, however, and have unbranched gills with sharper edges. The *Clitocybes* also prefer forests and woods. Here too there is produced the eery luminescence found in *Armillaria*. In *Clitocybe* it is the gills which give off light, a sort of greenish glow easily discernible in the woods at night, or in a dark room.

Collybia species have flattened or only slightly convex caps of a yellow or tan color. They prefer the ground among decaying leaves in woods and groves of trees.

The edible Milky Mushroom (*Lactarius*) can be recognized by the watery-milky juices which exude from them. The broad caps are centrally depressed, resulting in a shallow cup-shaped structure on a stocky fleshy stem. In color they vary from yellow to reddish brown; one species is a silvery blue,—an uncommon sight among the Fungi. They grow in light sandy soils.

The species of *Lentinus* have a tough, almost woody appearance; added to this unusual character is the fact that the stem is rarely central but rather on one side. The creamy white cap is broad and fleshy, in one species covered with brownish scales. It is a common saprophyte on wood, especially on railroad ties, bridge timbers and tele-



Polyporus is a small Bracket Fungus which forms tier upon tier of velvety brown growths along the sides of trees and fallen logs.

phone poles. Economically it is of considerable importance in the destruction of such woody structures.

The Parasol Mushroom is one species of the common genus *Lepiota*. It is a large, handsome mushroom, the six inch white cap, smooth or scaly, borne atop a stem often ten inches high. In some ways it resembles an *Amanita*, but the absence of a volva is a marked difference between the two. *Lepiotas* prefer fields, pastures and open woods.

The *Marasmius* mushrooms are small species which resemble the *Collybias*, except for the tougher caps. One species is called the Fairy-ring Mushroom,—a small plant an inch or two in height, with a flattened or slightly convex little tan cap. They usually are found in circles in lawns and other grassy places. Other mushrooms also form the so-called "fairy rings", however. This phenomenon is due to the fact that a mushroom spreads its spores outward in a circle from the parent plant; the spores that land on the central area already overgrown by the parent mycelium can not germinate, but those outside this area do. The result is an ever widening ring of mushroom growth. Even tinier than the Fairy-ring Mushroom is its relative, the Little Wheel Mushroom, whose half-inch diminutive caps on frail stems dot the dead leaves and bark of rotting logs with white fairy-like foot stools.

The Oyster Mushroom (*Pleurotus*) is a common tree growth. The broad white or tan caps are attached to the tree trunk by lateral stems, after the fashion of a *Leontinus*. Different, however, is the softer, less woody tissue of the Oyster Mushroom. In Europe this mushroom is not only collected and eaten, but cultivated on elm trunks in gardens because of its choice flavor.

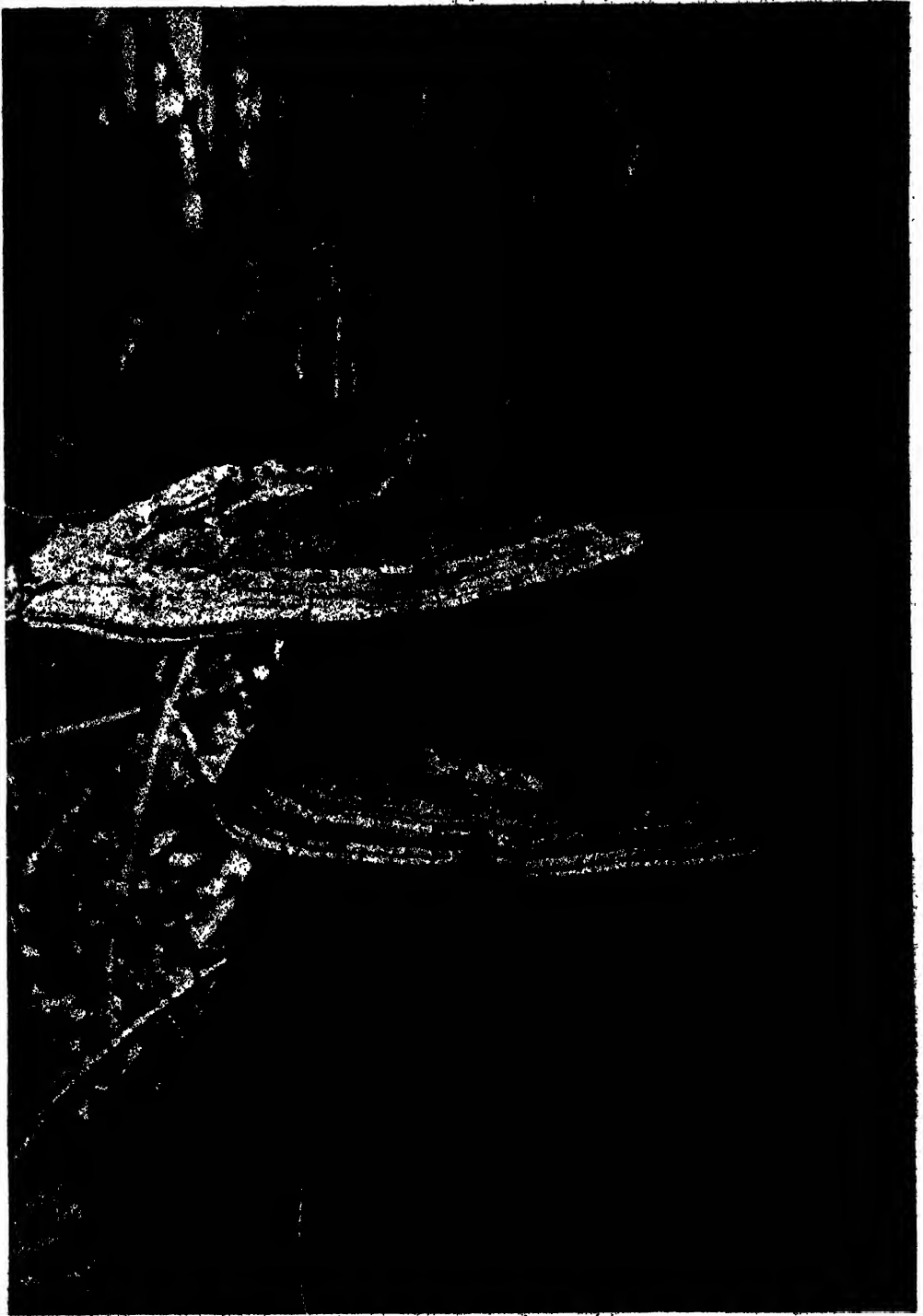
Last, but not the least common of the white-spored mushrooms, are the *Russulas*. All are characterized by rather dry and brittle flesh, the color of the cap varying from bright red and purple to brownish-green. One species (*R. emetica*) is considered poisonous, though not fatally so. All the species prefer woods.

THE PORE FUNGI

The Pore Fungi, or *Polyporaceae*, differ from the preceding group of the Gill Fungi in the arrangement of the spore-forming tissues of the cap. Instead of the radiating gills, the under surface of the cap consists of numerous tubes, the terminal openings forming a porous surface. Also different is the predominance of the woody or leathery fruiting cap over the softer, fleshy one which is typical of the Gill Fungi. The fleshy species are commonly called Mushrooms, the woody species, Shelf Fungi.

The edible Painted Boletinus (*Boletinus*) is one of the fleshy species, with a yellow cap, spotted with brown scales. The spore-tubes form a series of openings which are arranged more in radiating rows than any other of the *Polyporaceae*. It is a rather conspicuous plant, with a medium sized cap borne on a rather squat stem. Dark woods and swamps are its favorite habitat.

Somewhat similar, except that the pores do not form rows, is the genus *Boletus*. These very common mushrooms have a yellowish undersurface, with a smooth reddish-brown top to the cap. *Boletus* species are generally very firm in texture. The short, swollen stems, and the thick convex caps give the mushrooms a plump appearance.



The woody Bracket Fungi, such as *Fomes*, are the visible expression of a spreading hidden mycelium underneath the bark of the tree, which exhausts the vitality of the host until eventually death results.

The woody members of the *Polyporaceae* number at least six hundred species, and are common wherever there are standing or fallen trees. All are notorious destroyers of wood, the mycelium spreading beneath the bark of living trees and exhausting their vitality until death finally results. On the surface there is often no warning of the death struggle going on beneath the bark until the mycelium is ready to form reproductive organs. Then the little "brackets" or "shelves", often without stems, begin to appear on the sides of the tree. As the eating away of the tree proceeds, more and more of these fungous reproductive structures appear until often the whole trunk may be covered with them.

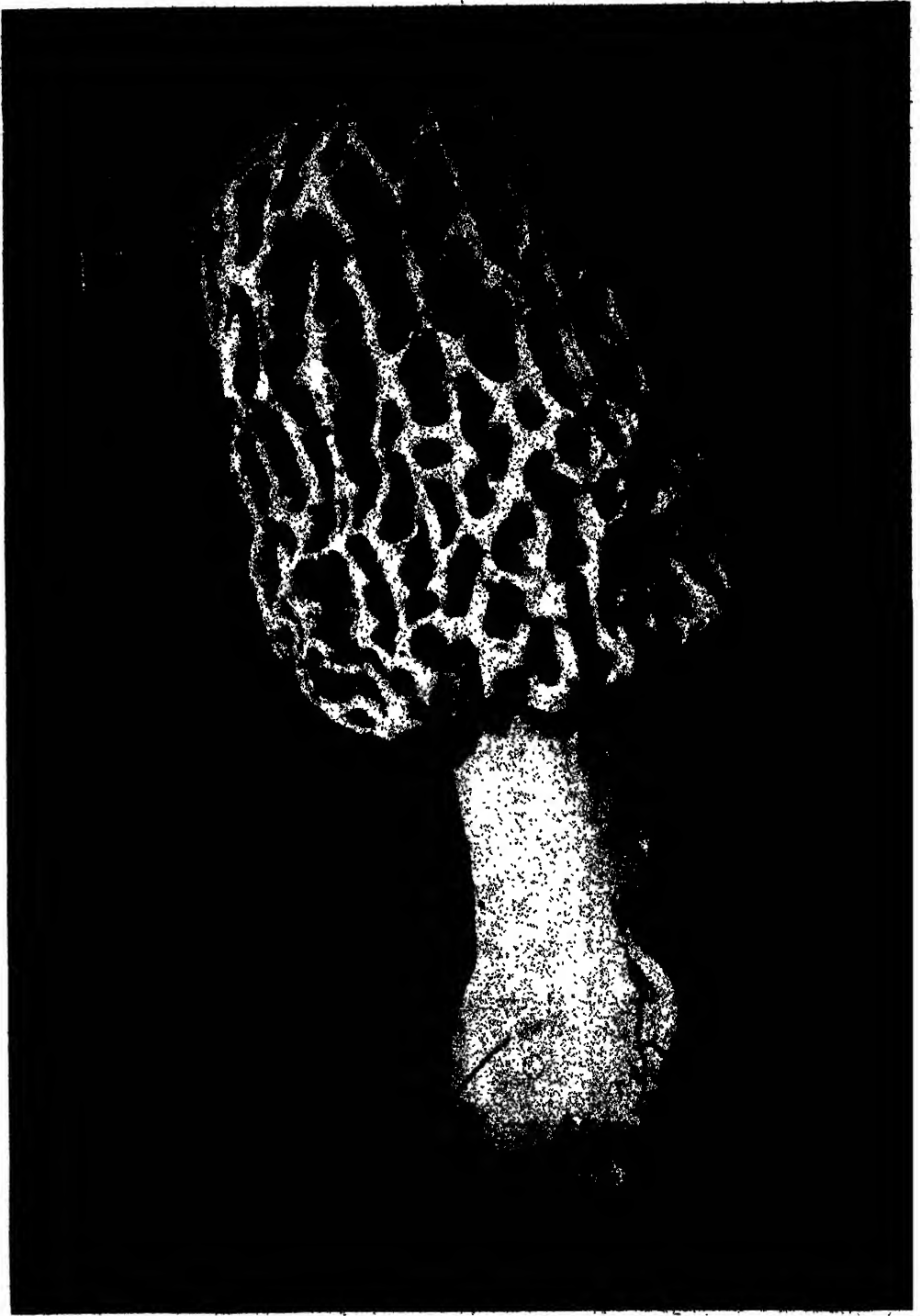
Polyporus includes many common species. One, more edible than the others, is known as Hen of the Woods. The lobed, twisted caps are of a smoky gray color and often quite leathery in texture when old. It often forms clusters about the base of oak trees. The Scaly Polyporus is another species, characterized by dark scales scattered over a dull white body. The tough cap is fan-shaped, attached to the tree by a stout lateral stem. The Chicken Mushroom is conspicuous because of its yellow or orange color, often a brilliant shade tinged with red. The mushrooms form a dense fleshy mass due to the irregular overlapping and fusing of the separate "brackets". It is an edible species, but also is harmful because of its ravages among oaks, maples, walnuts, pines and hemlocks. The Birch Fungus produces chalky white or gray fruiting bodies along the trunks of birch trees, while it is doing a thorough job of rotting the sapwood of its host.

One *Polyporus* forms tier upon tier of velvety brown outgrowths along sides of trees and fallen logs. Superficially beautiful, this fungus is also a live tree destroyer. More massive is the fruiting growth of *Fomes*, often known as the Hoof Fungus because of the similarity of the reproductive structure to a horse's hoof. *Dacdalca* and *Lenzites* are two other common Shelf Fungi; the former is distinctive in that the spore-bearing surface consists of winding and labyrinth-like slits, instead of pores, while the latter has slits which are more radially arranged. Both are corky or leathery, dull white to tan or gray in color.

OTHER FLESHY FUNGI

Even though the foregoing species include most of the common mushrooms and their relatives, no description of this unique world of colorless plants would be complete without mention of the Teeth Fungi, Club Fungi, Puffballs and Earth Stars, Bird's Nest Fungi, Morel and Truffles.

The previously described mushrooms produce spores either on the sides of gills or in tubes. In the Teeth Fungi (*Hydnaceae*) the spores are borne on awl-shaped teeth or spines which often hang downwards from the cap or drape themselves over the entire fruiting structure. The Bear's Head Mushroom (*Hydnum*) is a striking growth, its fleshy mass of pendant spines forming a weird white covering over the surface of fallen beech or birch trunks. The Hedgehog Mushroom is also fleshy and tuberous, its white formless mass covered with spines which suggest the wriggling snakes of Medusa's locks. This species shows a preference for rotting logs of oak, locust and beech trees. The Coral Hydnum, likewise common on beech trunks, forms a strikingly beautiful tangled mass of spinous tissues. Like all Hydnums, it is edible; but as one enthusiastic mushroom authority has written:



The edible Morel (*Morchella*) has a stout cone-shaped cap ranging in color from white to tan, marked with irregular depressions and ridges on which the spores are produced. Photograph by O. B. Stanley.

"—It seems almost sacrilegious to recommend it as food for the camper. . . . Let him turn to the more humble kinds to satisfy his craving for something to eat, and reserve this glorious *Hydnum* for a feast of the eye."

The Club and Coral Fungi belong to the family *Clavariaceae*, characterized by erect fruiting structures. The *Clavarias* prefer the rotting logs and stumps in mossy shaded woods, where their delicately white or yellowish coral-like growths spread over the substratum.

The Puffballs, or Pouch Fungi, are botanically known as the *Lycoperdaceae* whose special character is the spherical stemless sac in which the spores are produced. The subterranean mycelium grows in humus or the woody debris of fallen trunks and mossy stumps. As the fungus matures the fleshy white interior of the Puffball changes to a yellowish mass of spores which can be ejected from the hole at the top of the sac, issuing out as a cloud of brown dust-like particles. The common little Puffball, often found in clusters, is *Lycoperdon*. Giant of the mushroom world is the genus *Calvatia*, the Brain Puffball, which is common in grassy locations. The white or brownish mass may reach a diameter of several feet, and weigh five or six pounds. This fungus, instead of releasing the spores through an apical hole, cracks irregularly over its surface. The picturesque little Earth Stars (*Geaster*) are related to the Puffballs. Here the spore sac is a double structure; at maturity the outer coat ruptures into segments, forming star-shaped points around the central spherical spore sac. Often these radiating segments are recurved sufficiently to raise the central sac upwards into the air.

The Bird's Nest Fungi (*Nidulariaceae*) are curious little plants of inconspicuous size. The spore case breaks open at the top to form a nest-like growth in which the globular masses of spores lie like little eggs. In one species, the "nest" contains a single jelly-like spore mass; when mature, the spores are forcibly shot out of the "nest".

The two remaining common Fungi, Morel and Truffles, are more distantly related to the mushrooms. They belong to those Fungi known as the *Ascomycetes*, of which we shall hear more in the next chapter. Most of the *Ascomycetes* are molds or mildews, but have developed fleshy and rather massive reproductive organs, as in the case of Morels and Truffles.

The edible Morel (*Morchella*) has a stout, cone-shaped cap, ranging in color from white to tan, at the top of a stout fleshy stem. The spores are produced in the depressions and on the ridges of the irregularly pitted and ridged cap. Morels grow on the ground, the common edible one preferring old orchards and other similarly open wooded areas.

Truffles (*Tuber*) are entirely subterranean, the warty brown spore sacs as well as the mycelium, being produced entirely underground. Truffles have been considered a delicacy since the time of the early Greeks and Romans; but since they do not appear above ground, they are difficult to locate. This can be overcome by using dogs trained to scent the Truffles; in some countries truffle-hunting pigs are used. Pigs are able to scent a Truffle at twenty feet. The only drawback to using such "trufflers" is that unless one gets to the scene as soon as they do, the animal has himself eaten the delicacy.

THE SLIME MOLDS

Here and there, in both the animal and the plant kingdom, occur perverse groups of organisms which are difficult to fit into any scheme of classification. Sea-fans and sea-anemones hardly look like animals, and the swimming Green Algae do not conform to our ideas of what a well-behaved plant should do. There is an entire group of organisms which combine animal and plant characters to such a confusing degree that it is difficult to think of them either as typical plants or typical animals. These are the *Myxophyta*, in common language the Slime Molds. Since their closest relatives are the Fungi, they might be considered here.

The Slime Molds are non-green like the Fungi, since they lack chlorophyll; and similarly are dependent upon organic material for food. Most of the Slime Molds are saprophytes rather than parasites. The body of one of these plants is uniquely different from all other organisms in that it is a large mass of undifferentiated, unprotected, naked protoplasm. It is literally "life in the raw". This mass of protoplasm has no cell walls, is not organized into cellular units of any kind. In color it is gray or yellowish, about the consistency of the white of an egg. The formless jelly-like mass spreads over rotting logs and plant debris in the damp shaded portions of woods. A peculiar ability of this naked protoplasmic body is that it creeps slowly over the substratum, behaving like a gigantic Amoeba. The slimy body ingests bacteria and bits of leaves as it moves along, the waste material being left behind after digestion has taken place. In these characters,—the creeping movement and the method of eating,—the Slime Mold behaves like an animal.

When this body is ready to reproduce, small projections appear on the protoplasmic mass, eventually growing into spore cases on thin stalks. These spore cases are often cobwebby cylindrical or spherical structures, less than a quarter inch in height. When the spores are ripe, they are released and carried by the wind to a new locality. Under proper conditions (warmth and moisture) they become free-moving cells with flagella. In time these motile cells join with one another, hundreds coming together to form a new naked protoplasmic mass,—the vegetative body of a new generation of a Slime Mold. In these reproductive phases, the *Myxophyta* are typical plants.

Stemonitis is such a common Slime Mold, found on the bark of rotting logs; its sporangia are long, slender and tapering. Clusters of these sporangia, on their stalks, look like miniature sheaves of grain. *Arcyria*, another genus, has stouter, more cylindrical sporangia.

Warfare Among Plants



A MEADOW of waving grasses and nodding flowers gives an impression of peace and amicability which contrasts strikingly with the life and death struggles of the animals who stealthily move through its vegetation, intent upon killing each other. There is a constant struggle for survival as animals fight for food and self-preservation. As the cat slinks homeward with a bird in its mouth or the hawk carries off a young chicken in its talons, this ruthless competition, which is the law of nature, is forcibly brought home to us.

Such behavior seems entirely lacking in the plant world. Here, we feel, is a realm where there is enough food and space for everyone, where organisms do not have to live in constant danger from natural enemies, where every bit of life may reach its fullest expression without injuring other life. But unfortunately for the idealist, this is not so. Underneath its placid exterior the plant world is as rife with contest between individuals and species for survival, as is the world of animals. Much of this struggle is invisible, all of it is silent; yet it is a grim warfare without truce, with life as the reward to the victor and death to the luckless loser.

This struggle often centers about the getting of sunlight or water so essential for green plant nutrition. Where plants grow in the closest association with one another, the struggle is keenest. In tropical jungles there is water enough for all, but here the premium is on the ability of a plant to extend its leaves out to the sunlight. The weakling which can not grow as rapidly as its neighbor is overshadowed and soon dies in the shade of its competitors. There are many species of climbing plants which can twine about the trunks of trees, often extending a hundred feet without producing a branch or a leaf. When the climber gets to the topmost limbs of the tree, it unfurls its green leaves victoriously and drinks in the welcome sunlight. Often the forest giant, who played the part of an obliging ladder to the lighted zone, becomes strangled to death by the woody vines which, encircling the trunk, limit its growth.

In temperate regions and in deserts, the struggle often is to obtain water. Plants with the most rapidly growing or the most efficient root system get to the water-soaked soil first. The even spacing of the Spanish Bayonet plants in our Southwest is due to the amount of soil and water needed by one plant. Should a seedling begin growth between two established plants, it finds itself with too little water and as a consequence rarely lives to maturity.

Whenever plants of one species colonize an area, they are liable to be driven out by some other species which has developed a special ability to get the life essentials in that area. The constant battle between lawn grasses and dandelions, between garden plants and "weeds", typifies this constant competition.

But the greatest warfare is between the green plants and the colorless ones; it is the chlorophyll-bearers and honest laborers against those plants which must steal their sustenance from organic sources in order to keep alive. So well have the cohorts of the Fungi fitted themselves for their depredations upon the green plants, that they have increased in numbers to the point where today there is at least one fungus species for every three self-supporting flowering plants.

Wherever there is a green plant, there is a host of fungi lying in wait to parasitize it. Every breeze brings with it thousands of invisible spores which are the reproductive bodies of the Fungi. The single-celled spores lodge on the outside of the plant, where they remain unless they can find an opening into the living tissues. Some spores do so, often gaining entrance through the bark or through the minute breathing pores in the leaves. Once inside, the spore germinates into a mycelium of colorless filaments, like that of the mushrooms. But this mycelium, not content with dead organic material, grows through the plant tissues, pushing its way between the cells, frequently breaking into the cells themselves and leaving behind sucker filaments which feed upon the living protoplasm. As a result, the normal growth of the green plant is hindered. Death of a considerable number of leaf cells results in a yellowing, withering and eventual death of the whole leaf; if all the leaves are infected, complete defoliation of the plant takes place. And since the leaves are the food-manufacturers for the plant, this loss is a serious one and may result in the death of the plant. Destruction of cells in the flower may interfere with the normal formation of reproductive cells, and there will be no fruit nor seeds. Sometimes the host cells are stimulated to abnormal growth, as is the case with the common cankers seen on tree trunks, or the witches' brooms,—bunches of closely packed twigs forming a bushy growth on the branches of an otherwise normal tree. Usually Fungi do not bring death to the host until the mycelium is ready to form spores; these are released at the surface of the host where they are picked up by the wind and carried off to wreak more havoc in other green plants.

This warfare between the colorless and the green plants often results in harmless associations between the two. At other times the host is the victim of the intruder and, helplessly losing its vitality, faces certain death. When this warfare is extended to those plants upon which we depend for food, clothing, timber, and other important necessities, then the struggle becomes of importance to mankind and we join forces with the green plants. In this chapter we will describe a few of the plant diseases which have assumed economic importance; in many cases the cost of battling a single disease runs into millions of dollars, though the fungus plant itself may be an invisible microscopic organism of disarming simplicity.

The species of Fungi are grouped into three large classes on the basis of their reproductive habits. Most like the Algae is the first class, the *Phycomycetes*. Their vegetative body is made up of branching filaments which lack cross walls, and the small asexual spores are generally produced in unspecialized spore-sacs on stems,

known as sporangia. The Bread Mold is an example of a Phycomycete. The second class, the *Ascomycetes*, have a mycelium with cross partitions in the filaments; and the spores are produced in definite numbers inside of special little sacs known as "asci". In the previous chapter we have met two of the fleshy members of this class,—Morel and Truffles. The third class is the *Basidiomycetes*, to which the mushrooms belong; and, as already described, these produce spores on special portions of the filament known as "basidia".

Disease-producing Fungi are found in all three of these classes; many of the saprophytes among the mushrooms and their relatives often act as parasites and attack living green plants as well. Most of the plant diseases which have cost American taxpayers so many millions of dollars, belong to the *Ascomycetes*.

THE ALGAE-LIKE FUNGI

The *Phycomycetes* include many harmless species which occur as molds and mildews on the surface of organic material. But there are also the destructive Pond-scum Parasites, the Water Molds, the Downy Mildews, the White Rusts and the Black Molds.

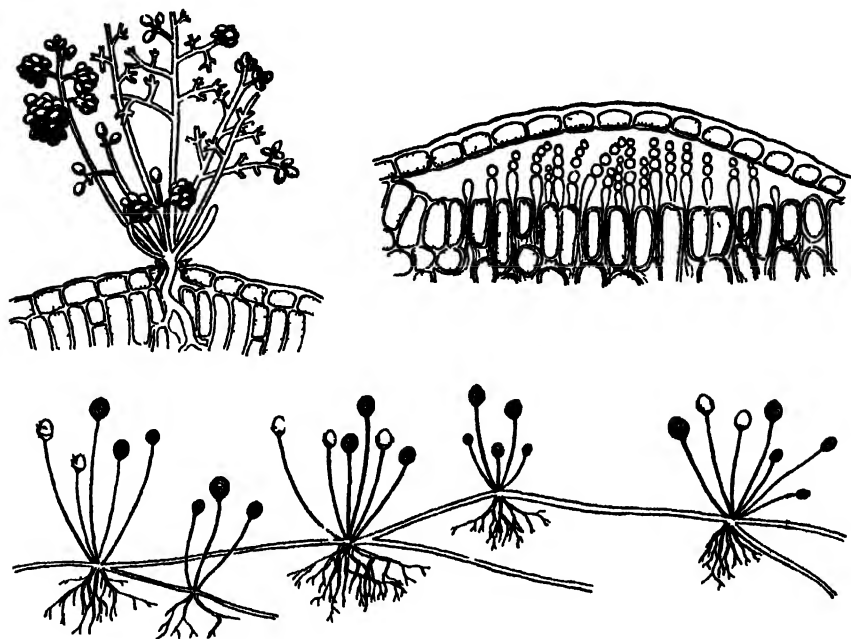
The most characteristic feature of the Pond-scum Parasites (*Chytridiales*) is their primitive nature, the whole plant being but a single cell. They live for the most part on aquatic plants, such as the Green Algae. There are a few instances of their infecting flowering plants. The Club Root of Cabbage is caused by a fungus (*Plasmidiophora*) which is often classified with the Slime Molds. The fungus cells invade the living tissues of roots, causing the distorted growth which is a characteristic of the disease. Infected plants decline in general vigor and eventually die. Seedling cabbages thus attacked generally die in the first month of growth. The Powdery Scab of Potato is a disease caused by another of the Chytridiales (*Spongospora*) which attacks the roots, tubers and stems of white potatoes, causing galls or scabs. In the tubers, the tissues surrounding the infected area take on a purplish hue.

The Water Molds (*Saprolegniales*) are aquatic saprophytes subsisting upon the decaying organic matter of ponds and roadside pools. At times, some of the species parasitize aquatic animals. There is a Fish Mold (*Saprolegnia*) which is of considerable economic importance in fish hatcheries; the fungus forms a grayish growth, especially over the gills. Infected fish gradually become more and more sluggish, eventually die. Other members of this group cause Root Rot of peas, tomatoes, sugar cane, sugar beets and radishes.

The Downy Mildews (*Peronosporales*) and their relatives are more common as parasites; some three hundred species are known to live within the tissues of flowering plants. They are the most highly developed of the Phycomycetes, forming a mycelium which surrounds the living cells of the host tissues, penetrating the cells and absorbing their food from the living protoplasm. When ready to reproduce, the mycelium breaks through the surface of the infected part of the plant, and produces spores in white downy masses which give the fungus its name. A serious disease of potatoes, the Late Blight, is caused by a Downy Mildew (*Phytophthora*) which attacks both leaves and tubers. Spores enter the leaves through the stomates, and soon a branching inter-cellular mycelium is formed which steals the life-giving food materials from the green cells. As the cells die, brown areas appear until finally the whole leaf is killed. At this time a fuzzy gray mass of spore-producing filaments with

their spores appear on the under side of the leaf. When the mycelium grows in the tubers, it causes a rotting of the tissues. This disease was so widespread in 1845 in Ireland that a serious famine resulted. A related Downy Mildew known as the Damping-off Fungus (*Pythium*) is a serious menace to young seedlings, while other species attack cereals, beets, alfalfa, clover, peas, roses, pansies and tobacco.

The White Rust is caused by a Mildew known as *Albugo*. This is found on the foliage, stems, flowers and fruits of various members of the mustard family, especially on cabbages and radishes. The mycelium forms blisters on the leaves which in



PHYCOMYCETES

Grape Mildew (upper left) and White Rust (upper right), both shown associated with leaf tissues, Black Mold

reality are areas of spore-forming filaments. The blisters break when the spores are mature, forming a powdery white mass. The fungus which causes the Downy Mildew of grapes (*Plasmopara*) has caused great damage among vineyards.

The Black Molds (*Mucorales*) include a great number of saprophytes which form a cobwebby mycelium over organic material such as moist food; they get their name from the dark color of their spores, since the mycelium is as usual colorless or gray-white. A Black Mold (*Rhizopus*) causes the Soft Rot of Sweet Potato which appears when sweet potatoes are stored in bins. Infected roots give off a clear liquid from the rotted areas, and a decidedly unpleasant odor. Another species of this fungus causes a similar rot known as Leak of Strawberries.

THE ASCUS FUNGI

The *Ascomycetes* include about half of all the known Fungi, their number being estimated at between thirty thousand and forty thousand species. Many are harmless saprophytes common in the woods; others are useful, as the Yeasts, Truffles and Morels; but there is in this class also a great number of destructive plant diseases. Except for the Yeasts, all of the species form a mycelium which grows chiefly within the nutrient substratum. The asci, with their spores, are produced in a variety of ways. Sometimes they may be scattered over the surface of the mycelium and the substratum; at other times they are a part of special reproductive structures which look like little saucers or cups made up of sterile tissues with the asci forming a lining to the cup. Many of the *Ascomycetes* are for this reason known as Cup Fungi. When the reproductive cups are on stalks, goblet- and urn-shaped structures result. In still other *Ascomycetes*, the asci are inside of ornamented spherical bodies.

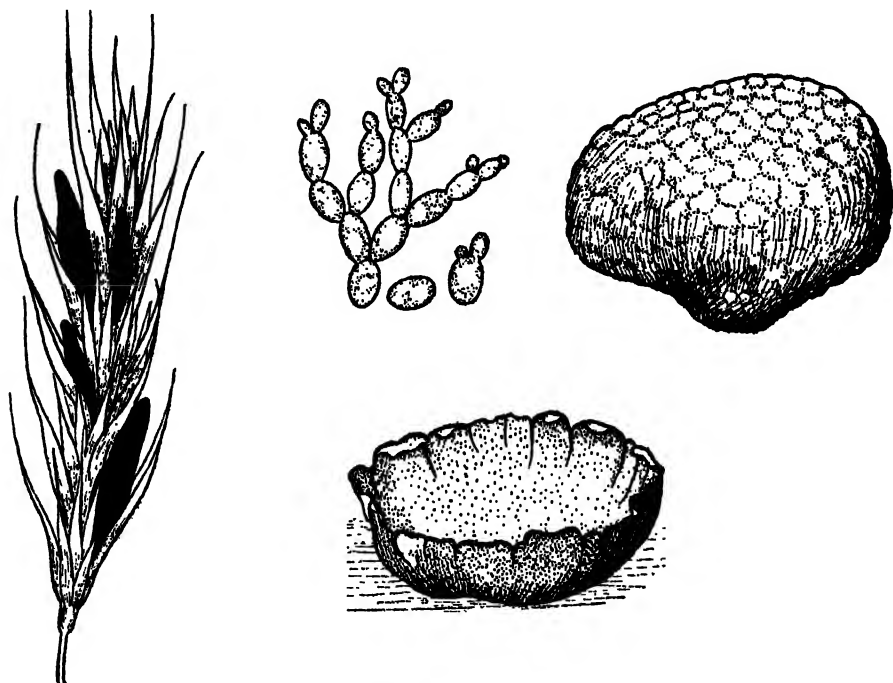
Some of the members of this class, as we have already seen, are considered mushroom-like plants. Such are the fleshy Truffles and Morels. Others are less like the mushrooms, but almost as common. These are the various Cup Fungi (*Pezizales*). *Peziza* is a fungus with a reproductive cup of a yellowish or orange color, often translucent, and noticeably moist. It grows out of the rotting log without any stalk, and forms an irregular bowl several inches in diameter.

Perhaps the most unusual member of the *Ascomycetes* is the Yeast (*Saccharomyces*). A cake of yeast is the last place one would look for living plants, yet the cake is nothing but millions of microscopic single-celled Yeast plants combined with nutrient material. In their reduction of the plant body to the confines of a single cell, the Yeasts are like the Bacteria; but the structure and behavior of this cell indicates a much higher type of organization. Yeasts are grouped with the *Ascomycetes* because at times they reproduce by means of the whole cell functioning as an ascus, producing one to four ascospores. Ordinarily they reproduce by budding; an individual plant develops a swelling on its side which soon grows into another plant and separates to lead its own existence. Yeast plants occur wild in the atmosphere, but the commercial Yeast used in brewing and bread-making comes from carefully controlled cultures.

Yeast is important because of its peculiar method of respiration. Ordinary respiration, or breathing, releases energy from organic foods by oxidizing them; and for this process oxygen is essential. The Yeast plants, when they cannot get oxygen, get their energy by converting sugar solutions into alcohol and carbon dioxide. This is a type of respiration known as fermentation. The wild Yeast plants are carried by the wind to the surface of the fruits; crushing the latter brings the Yeast in contact with the fruit juices and fermentation follows, producing cider or wine. In bread-making the Yeasts change some of the sugar in the dough to alcohol and carbon dioxide; the latter gas forms cavities in the dough which as a result "rises" to form leavened bread. For centuries mankind knew that letting the dough stand, exposed to the air, made it different from unleavened bread. And for perhaps even more centuries, mankind had capitalized fermentation in making alcoholic beverages. But it was not until Pasteur's researches of the last century that the role of micro-organisms, especially Yeast, in these processes was known. Some bacteria and several other

species of fungi can also be utilized commercially in producing alcohol by fermentation.

Disease-producing Ascomycetes include a number of Leaf Curls, Cup Fungi, Powdery Mildews and Sphere Fungi. The Leaf Curls (*Exoascaceae*) attack forest and fruit trees, especially oaks, birches, poplars, alders, peaches, plums and cherries. When the mycelium pervades the leaf tissues it causes spots and discolorations, often associated with a deformation which gives the leaves a crinkled and puckered ap-



ASCOMYCETES

Ergot (left) infesting rye; Yeast; Cup Fungus (lower right), Truffles (upper right).

pearance. Some species cause Witches' Brooms and abnormal flower growths. The Peach Leaf Curl, caused by *Taphrina*, changes the normal leaves of peach trees to thickened, curled ones. The bright ruddy color of the diseased leaves is very noticeable. Later in the summer the red color changes to brown as the leaves die, and at this stage the spore masses form a powdery bloom on the surface of the leaves. A conservative estimate of the loss in one year to the peach growers, as a result of Leaf Curl, had been put at \$3,000,000.

Among the parasitic Cup Fungi (*Discomycetes*) there is the Brown Rot of stone fruits which is found on foliage, twigs, flowers and fruits. When it occurs in the flower, this blighting is serious since it precludes fruit formation. The Anthracnose of Currants is caused by another Cup Fungus (*Pseudopeziza*) which appears as minute brown spots on the leaves. When there are many of these on a leaf, the latter becomes a yellowish color, and if all the leaves are infected the whole bush loses its normal

green color and consequently is severely stunted or killed. Other genera cause leaf spots on alfalfa, cherries and maples.

The Powdery Mildews (*Erysiphaceae*) form a delicate cobwebby mycelium on the surface of the leaves. From this mycelium, special filaments project into the leaf cells and extract nourishment from them. In the reproductive phases of the fungus life history, the filaments form a powdery mass of special reproductive structures in the form of little spheres, each provided with appendages and ornate outgrowths, and each containing the spore sacs with their supply of spores. The Powdery Mildew of the Apple (*Podosphaera*) attacks young apple tree shoots, stunting and killing leaves, blossoms and fruits. Other Powdery Mildews attack peaches, roses, strawberries, peas, grapes, cherries, grasses and cereals.

The Sphere Fungi (*Pyrenomyces*) have a spherical spore cavity; when the asci are mature, they forcibly eject the spores in rapid succession, with explosive violence. A common Sphere Fungus (*Claviceps*) attacks the flowers of various cereals and grasses, causing Ergot. The kernels of the fruit are displaced by hard, dark brown reproductive filament masses of the fungus, which resemble spurs as they stick out amid the normal fruits of the ear of grain. Rye, wheat, oats and barley are the cereals usually attacked. In addition to loss of grain, consumers of ergotized rye—or other cereal—are poisoned. Throughout the Middle Ages there were frequent epidemics due to ergot poisoning, the last occurring in Lorraine in 1816. Cattle, horses and chickens are also poisoned by eating infected grain, developing gangrene and paralysis of the limbs. The Ergot contains various poisonous substances, one of which (ergotine) causes contraction of muscles such as those in the walls of blood vessels; it is used as a drug for this purpose.

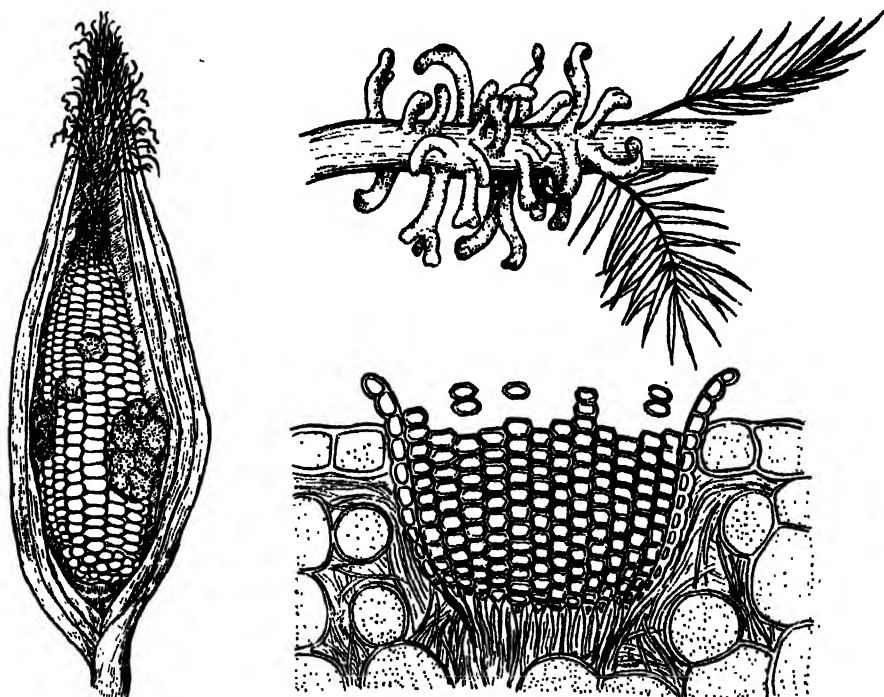
One of the most notorious of plant diseases is the Chestnut Blight (*Endothia*). This first appeared in New York City, in 1904; soon it spread throughout northeastern United States, being particularly destructive in New England. The estimate of loss of merchantable timber and shade trees, up to 1911, was \$25,000,000. The fungus gains entrance through wounds in the bark, and in this way invades the underlying growing tissue. The cottony mycelium spreads rapidly until eventually it completely encircles the trunk. This causes a girdling of the tree, with death to all those limbs and branches thus cut off from the root system. The superficial appearance of the fungus is at first a number of raised yellowish-brown patches; later on cankers and limb deformities, cracked by fissures, can be seen. The number of standing dead chestnut trees, still impressive in their size and stateliness, which can be found in any eastern forest, is mute testimony of the efficiency of this fungus attack.

THE RUSTS AND SMUTS

Among the *Basidiomycetes*, whose representatives the mushrooms were considered in the previous chapter, there are two groups of very destructive disease fungi,—the Rusts and the Smuts.

The Rusts (*Uredinales*) include some one thousand species in America alone; they get their name, as so many of the disease fungi do, because of the characteristic appearance of their reproductive bodies which form orange or reddish spots on the surface of the host plant. The mycelium, made up of filaments with yellow oil drops

in them, forms a ramifying network between the cells of the tissues; occasional filaments penetrate the cells and form sucker organs for abstracting the essential food. At first this mycelium stimulates the cells to abnormal growth, but eventually many of the cells are destroyed. A peculiar character of the Rusts is that they use two hosts in their life cycle, much like the malarial parasite in its alternation between mosquitoes and men. The Orange Rust alternates between Asters and Goldenrods, and various Pines; the Blister Rust between Pines, and Currants or Gooseberries; the Poplar



BASIDIOMYCETES

Smut (*left*) infesting ear of corn; Apple Rust (*upper right*); Stem Rust (*lower right*).

Rust between Poplar and Larch; the Apple Rust between Apples and Cedars; the Rust of Stone Fruits between Hepaticas and Anemones, and Almonds, Cherries, Peaches or Plums. It is fortunate in control of the Rusts, that the eradication of one host generally means control and decline of the fungus disease.

The Stem Rust (*Puccinia*) attacks various grasses, wheat, oats, barley and rye; and continues its life cycle on the wild barberry. This disease, known since 1797, caused a destruction of a half a billion dollars worth of wheat between 1911 and 1914, in the United States alone. The spores are carried by the wind, entering a new host plant through the leaf pores. The spore germinates into the filamentous body which grows between the living cells of the leaves and stem, extracting its food from them. When ready to reproduce, the filaments form several kinds of spores, depending upon the time of the year and the host. When the fungus in the barberry forms yellowish

reproductive structures which appear as spots on the leaves, the danger to cereals is the greatest. Spores produced in these cluster-cups on the barberry can live only if they reach a cereal plant. Later in the season, the fungus forms spores of two kinds on the cereal host; one of these types of spores must reach a barberry host in order to germinate and live. Prevention of this disease obviously lies in the eradication of barberries growing in proximity to wheat, oats, barley or rye fields.

The Apple Rust (*Gymnosporangium*) attacks the leaves and fruits of apple trees, where the first symptoms are the orange yellow spots on the upper surface of the leaves. Later, these spots form blisters on which tubular projections develop, producing spores. Infected leaves fall off thus limiting the food-manufacturing abilities of the tree. The Rust causes dwarfing when it occurs in the fruit itself. When transferred to cedar trees the disease takes the form of brown galls which first appear as tiny globular structures, late in spring. The second season, these galls produce orange colored gelatinous horns which twist about like petals of a flower. Spores are produced on these galls, and carried by the wind to apple trees which then become infected.

Brought most frequently to the attention of the tourist, who is attempting to carry pine trees from one state to another is the White Pine Blister Rust (*Cronartium*) which was introduced into New England from Europe around 1900. The spores produce mycelia inside the pine needles which soon make withered brown corpses of hitherto lustrous green foliage. From the pine, the fungus spores travel to the wild barberry and currant bushes where the rest of the life cycle is completed. This disease spread so rapidly throughout the White Pine areas of northeastern United States that it threatened to wipe out the pines, just as the Chestnut Blight had threatened the chestnuts. But prompt and vigorous action, including quarantining of infected regions and eradication of gooseberry and currant hosts, has brought the disease under control.

The Smuts (*Ustilaginales*) get their name from the sooty black masses of spores. There are some four hundred species which attack the important cereal crops and a few other flowering plants such as onions, spinach and sunflowers. The plant body, like that of the Rusts, consists of a branching mass of colorless threads which may pervade the entire host plant, or may be restricted to certain organs. They cause a lowering of the vitality of the host, which as a result shows a stunted and impoverished growth. Eventually the mycelium, in localized areas, bursts through to the surface to form swellings and tumors in which the spores are formed. There is no alternation of hosts.

The Stinking Smut of Wheat (*Tilletia*) affects the wheat yield by replacing normal kernels in the ear with black powdery masses of spores. Infection occurs when the wheat is a seedling, but the disease does not manifest itself until the plant reaches maturity. Then the fungus gets into the ovary of the flower, destroys the potential embryo and in its place leaves the reproductive bodies of the Smut.

A single wheat seed may carry two hundred thousand Smut spores, so that infection of an entire field through a few diseased seeds is possible. Since the spores are fairly resistant and can live over several seasons in the soil, successive crops in the same region will show the same diseased condition.

The Loose Smut of Wheat (*Ustilago*) results in complete destruction of the

spikelets, every kernel metamorphosed into a black Smut spore mass. Spores infect new plants through the flowers, where they germinate and begin destruction of the ovary tissues. A somewhat shriveled condition of the grain is the only external indication of the disease. With apparently diabolical cunning, the mycelium of the Smut lies dormant within the seed until it is planted. Then, as the seedling grows to maturity, the Smut plant keeps pace with the growth of the host plant so that by the time of flowering, all the flowers are infected and the grain ready to carry the disease on to another generation.

BACTERIAL PLANT DISEASES

In the animal world, most of the diseases are caused by Bacteria, very few by Fungi. We have seen the importance of Fungi in causing plant diseases. But there is also a small place for the Bacteria in this warfare of plants among themselves. Bacteria are responsible for diseases found among some 150 genera of plants,—a few of these are cone-bearing plants but the majority are among the flowering species. The disease-producing bacteria are all of the rod-shaped type, with or without flagella; in their destructive relationships with green plants they bring about three types of disease.

The foliage of a plant receives its life-giving water from the root system, where it is absorbed, by means of many minute tubes which traverse the length of the stem or trunk. Some of these conductive channels convey water, others carry dissolved food from the leaves to regions of storage or use. Often the bacteria invade these water-conducting tubes (roughly corresponding to our blood vessels) and so fill up the vessels that water can not flow freely from the roots to the leaves. Deprived of their vitally important water, the leaves wilt and die. Such is the common Cucurbit Wilt of various gourd plants, caused by *Bacillus*. In the Brown Rot of the Nightshade Family (caused by *Pseudomonas*) the diseased vessels become stained brown or black; often the bacteria move on to the pithy tissues which are soon filled with black bacterial cavities. This is a costly disease of potatoes, tomatoes, egg-plant and tobacco. In the Black Rot of the Mustard Family (also caused by a *Pseudomonas*) the bacteria enter through the leaf veins, turning them a dark brown as they move downwards to new food areas. Wilting is not as characteristic a symptom in this disease as in the preceding. Cabbage and cauliflower heads are dwarfed and rendered unfit for use; the whole cabbage head is often diseased and becomes an offensive-smelling object because of the setting-in of a soft rot.

In a second type of bacterial disease, the microbes attack the soft tissues outside of the conductive channels, known as parenchyma. At first the masses of bacteria thrive in the spaces between the cells, then digestion of the cells takes place and eventually the cells are all killed. The Fire Blight (*Bacillus*) causes such a spotting, blighting and rotting among apples, pears and quinces. The disease affects blossoms, leaves, twigs and trunks of the trees.

A third way in which bacteria affect plants, is in the abnormal stimulation of various plant organs to unusual activity or growth, resulting in many types of galls and tumors. The genus *Pseudomonas* is responsible for many such growths, the commonest being the Crown Gall found at the base of the trunk of fruit and shade trees.

These are a few of the participants in the constant warfare that goes on between the Fungi and the green plants. Not a pleasant picture, perhaps, but yet such an important aspect of the plant world that it can not be ignored in any consideration of plant life which professes to survey *all* the important aspects of plant activities. It may be reassuring to those who feel that parasitism is distinctly a human affliction to know that even among the plants such conditions exist.

CHAPTER VI

Plant Co-operatives



NATURE seems to delight in contradictions. We have just seen the great number of ways in which plants have become adapted to prey upon other plants, and have discovered that the plant world includes much competition and many devious methods of gaining an effortless livelihood at the expense of other organisms. But there is co-operation, as well, in the plant world. Some plants live in an intimate relation with others, in an association known as symbiosis, whereby both partners in the relationship profit by the arrangement. The best example of such a plant co-operative is to be found among the lichens.

Lichens (*Lichenes*) are common plants which grow at our very doorstep—on the stones of our garden wall, the bark of our trees, the roofs of our houses. They are rarely noticed, however, because of their insignificant size, their neutral gray-green color (with a few exceptions), and the absence of such conspicuous reproductive structures as occur among the mushrooms or the flowering plants.

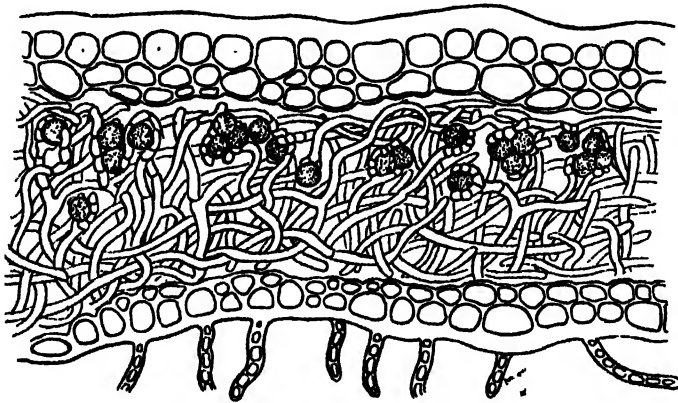
Anyone who has climbed above the timber line on our mountains has noticed the ashy gray or black patches on cliffs and boulders. These are actually live plants—lichens—which cling so closely to the rocks. On sea cliffs subjected to much fog or spray, the wrinkled papery crusts form colorful orange splotches which brighten the otherwise dull tints of the bare rock. Often these little plants grow so tenaciously to the rock that it is impossible to dislodge them. The lichen collector must bring fragments of the rock itself home with him, if he wishes to secure the plants. It is difficult to realize that these dry crusts which penetrate the rocks are really growing things. Other lichens are found in the woods of our northern states, where much of the ground is covered with the spongy Reindeer Moss. In the same areas, the spruces and firs may be trimmed with the pale green streamers of the lichen appropriately named Old Man's Beard.

The lichens are dual plants, made up, as we shall see later, of a fungus and an algal element. Instead of developing roots, stems and leaves, the lichen grows into either a flattened crust-like plant or an erect bushy one resembling a gray coral or sponge. In a few instances the thallus takes the form of delicate branching hair-like growths which hang from the limbs of trees.

Lichens are very widely distributed, and because of their ability to withstand extremes of temperature they can survive in cold regions where other plants are un-

able to live. For this reason they seem more abundant in the cooler temperate and polar regions where they have little competition, often forming the only vegetation. In such cold countries as Iceland and Greenland, lichens are the dominant form of plant life. But they will grow anywhere where there is ample light, a firm substratum and sufficient atmospheric moisture. For them, fog and dew are much more desirable than rainfall since, having no roots, they absorb most of their water from the atmosphere. Lichens are most particular about the pureness of the air. They are very sensitive to any gaseous impurities, and therefore are rarely found near cities where the smoke and the fumes in the atmosphere are lethal to them. Nothing but unpolluted air will suit a luxuriant lichen flora.

Lichens are of interest chiefly because they are the pioneers of the plant world.



LICHENES

Section through lichen thallus showing green algal cells (*stippled spheres*) surrounded by the hyphae threads of the fungus partner.

They are the first living things to colonize a barren rocky area, since they are the only plants that can gain a foothold and maintain an existence on dry rock surfaces. After they have covered the inhospitable substratum, other plants are able to take root, living upon the small amounts of humus and disintegrated rock resulting from lichen activity. Thus the mosses and grasses appear, cover the lichens with their roots and foliage, and in the process crowd out the hardy pioneers. But the reign of the mosses and other spore plants, with the grasses, is short-lived. For as more humus accumulates, seeds of woody plants are able to germinate, and the flowering plants in their turn dispossess the small mosses, ferns and grasses. Perhaps a few decades after the first lichen pioneer has taken possession of the bare rock, enough soil has been formed to enable forest vegetation to thrive.

This succession of plant life is taking place today in countless areas, where the vanguard of the plant kingdom is advancing to colonize the earth's crust. In by-gone eras such plants as the lichens, in similar fashion, may have played an important role in the transformation of barren land areas into fields and woodlands.

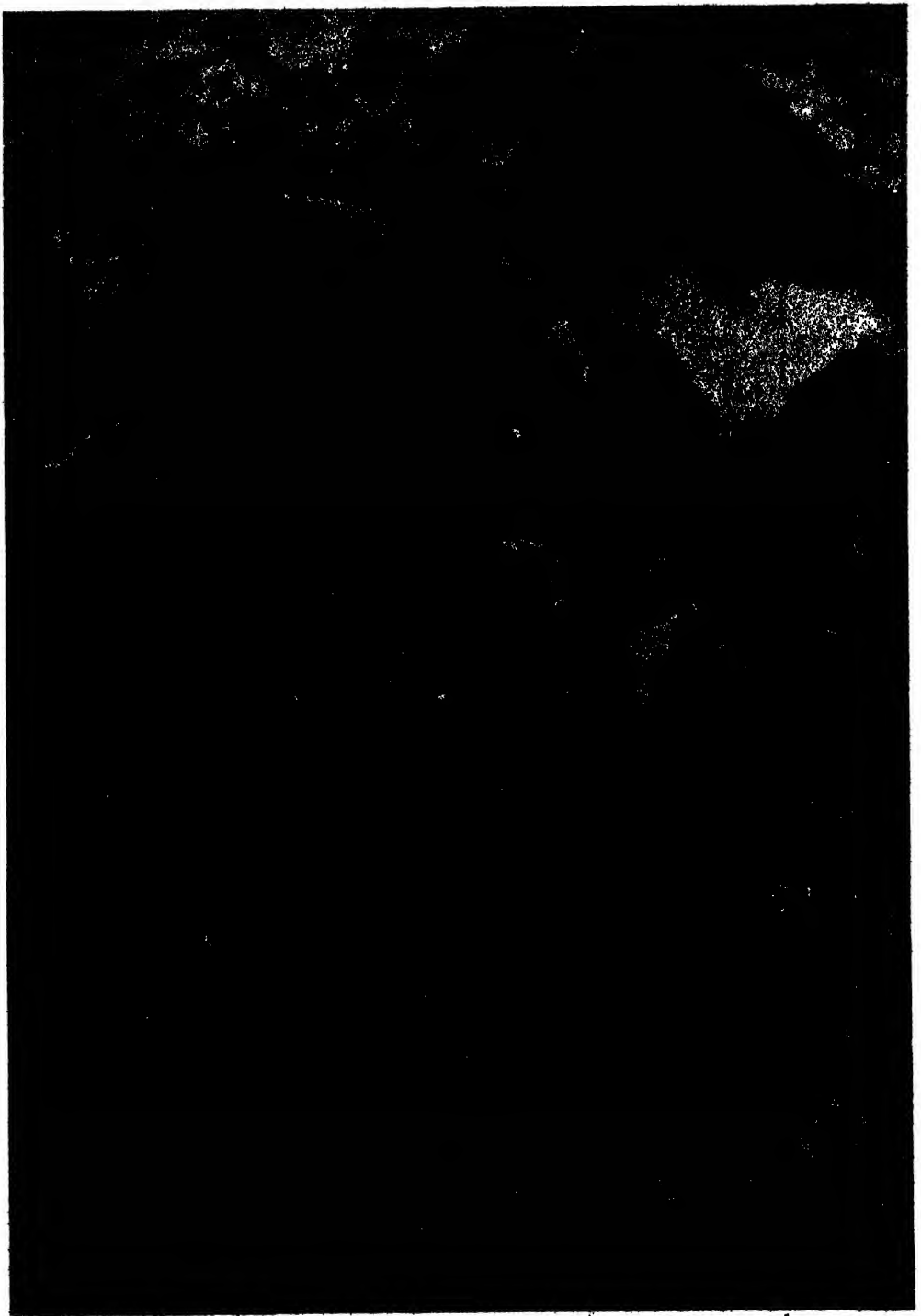
It may seem incredible that any plant can live on barren dry rocks, but nevertheless lichens can do so. This ability is due to the fact that each lichen is not a single plant



The cool damp woods of Maine furnish a paradise for the Lichen enthusiast; rocks, ground and trees are often covered with a dense growth of these gray-green delicately designed plants.



The Crust Lichen (*Parmelia*) forms compact radiating growths on rocks, whose color they often closely resemble.

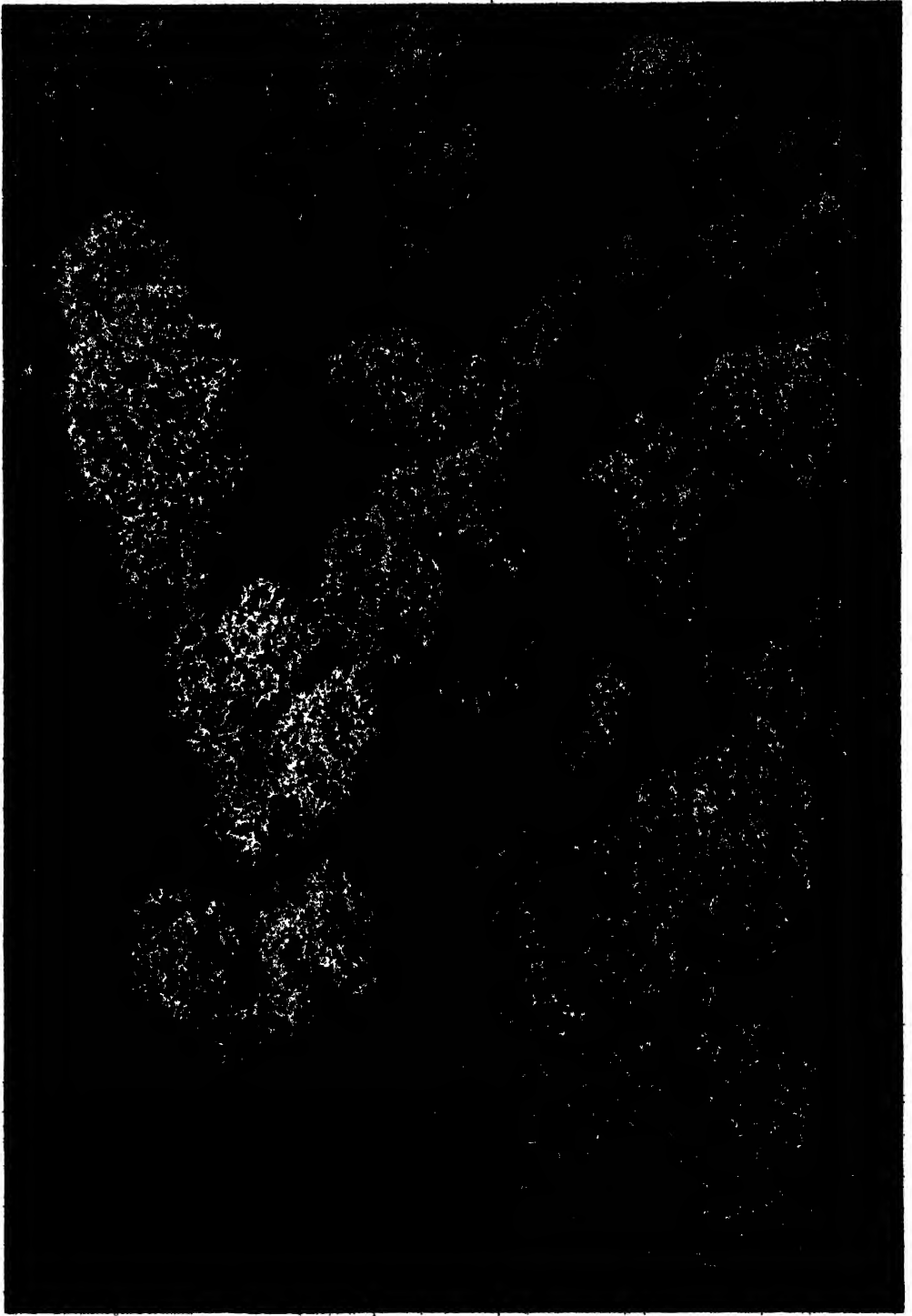


Rock Tripe (*Umbilicaria*) is a smooth dark green Lichen with a sooty black undersurface, attached by a central mass of rhizoids, the curled-up edges hanging as they will from the rock surface.

but a dual one ; it results from a co-operative association of a green plant and a colorless one living amicably together. The bulk of the lichen's body is made up of fungus filaments which form a tangled network of threads,—the vegetative portion of an *Ascomycete* fungus. In a few instances the fungus is a *Basidiomycete*. Intermingled with these filaments, especially in the upper layers of the lichen, are the green plants,—unicellular algae related to the *Protococcus* plant found on tree trunks. Most of the green plants in the lichen partnership are Green Algae of this type, though a few of the Blue-Green Algae are also found in this peculiar relationship. The fungus filaments attach themselves to the spherical green cells, so that the two organisms are able to actually exchange food materials with one another. The life of the lichen is therefore a constant give-and-take between the Alga and the Fungus which make up its body. The green plant manufactures carbohydrate food by absorbing moisture and carbon dioxide from the air ; what the plant does not need is in turn absorbed by the fungus filaments. In return, the fungus produces acids which disintegrate the rock, thus anchoring the lichen closely to the substratum in a fashion impossible for any other type of plant to attain. The fungus or the alga alone could not live on the rock, since the former demands organic, not inorganic, food materials ; and the latter would soon become dessicated if the fungus filaments did not aid by storing water and thus keep the green cells from drying out.

The upper surface of the lichen is usually thickened and protective, while the lower surface develops hair-like anchoring structures known as rhizoids. Lichens grow so slowly that it often takes many years to increase the area they cover by a few square feet. The combination of green cells and colorless ones explains the prevalent gray color of lichens. The fungus filaments cover the algae sufficiently to obscure their bright green color. When the lichen is dry it is a chalky gray color because then the green cells can not be seen through the mass of fungus filaments. When moist, lichens appear green since in this condition the moistened filaments transmit the light more completely and the color of the algal components of the plant shows through the fungus filaments. There is also a difference of texture between dry and wet lichens. Reindeer Moss becomes brittle and crumbles beneath one's feet during a dry spell ; whereas during a damp season, or early in the morning after a heavy dew, these same plants are soft and resilient as rubber sponges. Lichens are occasionally other colors than gray ; some become black, especially when dry, while others are a bright yellow or orange due to certain acids produced by the fungus filaments. These acids may be of value to the lichen in making it less desirable as a food and hence protecting it from its natural enemies,—snails and insects. It is also possible that the acids, formed on the surface of the filaments, prevent the spongy network from becoming saturated and water-logged during periods of submersion or heavy rains.

Lichens were known to the ancient Greeks, Romans and Hebrews. One genus (*Rocella*) was used as a source of blue and purple dyes. Several genera were thought to be of medicinal value because they resembled portions of the human body. Thus Old Man's Beard was supposed to be a hair restorer, Lungwort was considered a cure for chest troubles, Yellow Wall Lichen was believed good for jaundice, and Dog Lichen was given in cases of hydrophobia. The nearest approach to any specific chemical use of lichens in recent times has been the manufacture of litmus solution from them. Litmus solution is a blue color, which changes to red when an acid is added



Reindeer Moss (*Cladonia*) forms continuous carpets of gray coral-like growths over earth and rocks.

to it. Making the solution alkaline restores the blue color. Paper treated with this solution is used in all chemistry laboratories.

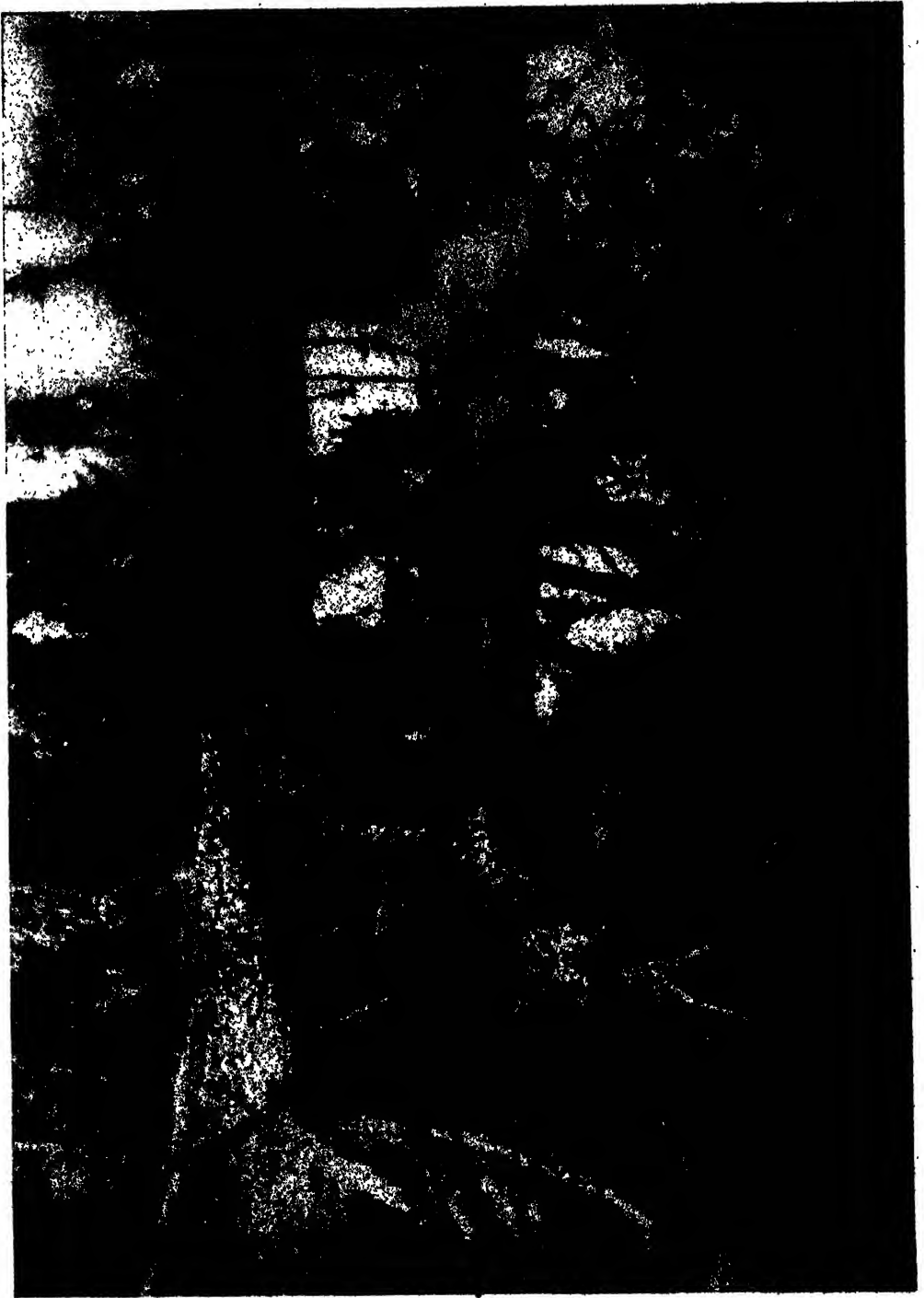
Lichens are not generally useful as foods. This is due to the lichen acids which make the plants bitter and indigestible. Arctic explorers have tried to subsist on them with little success. Some few species, however, are palatable. Perhaps the most famous of lichens, historically, is the manna (*Lecanora*) of the Israelites. This grows in northern Africa and western Asia, loosely attached to rocks and soil. A strong wind can dislodge great quantities of this lichen, rolling the irregular brown lumps, varying from the size of peas to that of walnuts, over the ground until they collect in depressions. Even today desert tribes of this region grind the lichen into a meal from which they make bread. Reindeer Moss is apparently a satisfactory food for animals, being the mainstay in the winter diet of reindeer, lemmings and other cold-climate animals. Iceland Moss contains enough starch-like food so that the plant is eaten by the Icelanders; cooking this lichen results in a gelatinous substance which is very digestible and often made into soups for invalids.

When lichens reproduce, it is the fungus partner which forms the reproductive structures. On the surface of the lichen typical Ascomycete reproductive structures appear in the shape, in many instances, of cups or stalked goblets. Part of these structures often is a bright red. Here are produced the spores, which are dispersed by the wind. If the spore finds some of the green algal cells, it germinates in close association with them. As the green plants increase in numbers by simple cell division, the fungus also produces new filaments. Soon a new lichen thallus is formed, exhibiting all the characters of the parent lichen from which the fungus spores were derived.

There are some ten thousand species of lichens. They are all, however, variations on a few simple thallus patterns. There is the crust-like plant, prostrate and lobed, looking like a leaf fragment cemented to the rock surface. Many of the common lichens are of this type, forming firmly attached plants with a radiating growth which results in circular or fan-shaped habit. These are found on stones, cliffs, tree trunks, fences and logs more often than on the ground. Other lichens are ground-dwellers, forming bushy branching plants a few inches in height and generally with a coral-like appearance.

Of the crust forms, we might mention the *Parmelia* Lichens, the Yellow Wall Lichen, the Rock Tripe, the Lungwort and the Dog Lichen.

Parmelia (*Parmelia*) lichens commonly form small radiating growths closely attached to the rock or bark on which they are growing. Usually they are an inconspicuous gray-green color. The Yellow Wall Lichen (*Theloschistes*) is similar in habit of growth, but is conspicuous by its brilliant orange color. Some of the islands off the Maine coast have cliffs so covered with these lichens that at a distance the whole island takes on a golden-yellow hue. Rock Tripe (*Umbilicaria* and *Gyrophora*) is a large lichen, smooth dark green on its upper surface and sooty black beneath. A central mass of rhizoids holds the lichen to the rock on which it is growing, allowing the curled-up edges to hang as they will. Rocky walls of ravines are at times covered with these dusky plants, which are said to be edible. Lungwort (*Sticta*) is a leaf-like lichen common on tree trunks. The surface is indented and marked with depressed areas which bear a remote similarity to the appearance of lungs. The surface is leathery and tannish gray when dry, changing to a bright green when moist. The



Old Man's Beard (*Usnea*) superficially resembles Florida Moss; the gray hair-like tufts hang from the twigs and limbs in great abundance in our northern coniferous forests, giving the woods a hoary and venerable aspect.

Dog Lichen (*Peltigera*) grows in extensive patches on damp logs and earth. The thallus is dark brown, almost black. The reproductive structures project like yellow teeth which resemble the canines of a dog.

The coral-like lichens are commonly found in large patches on sand, earth and level rocky ledges. This is the case with the branching, strap-shaped thalli of the Iceland Moss (*Cetraria*) and the bushier growths of the Reindeer Moss (*Cladonia*). Seldom do these plants exceed a height of six inches, but they make up in profusion of growth what they lack in stature. The Reindeer Moss forms continuous carpets on the open sunlit areas of the forest floor. In the New England mountain region, *Cladonias* cover all the level rocky ledges and otherwise barren stretches of earth with their coral-like dense growths. One species of this genus forms minute fairy-like mantles on old stumps and rotting logs, some of the twisted gray stalks bearing at their summits bright red reproductive organs; it is well named the Scarlet Crested *Cladonia*.

The Old Man's Beard, or Bearded Lichen (*Usnea*), superficially resembles Florida Moss. But the latter is a flowering plant of the Pineapple Family, living in the southern states. *Usnea* is a thallus plant, its hair-like tufts hanging from the twigs and limbs of trees in our cool coniferous forests. The hanging clusters of gray-green threads give the woods a hoary and venerable aspect. A spruce glade draped with Old Man's Beard becomes a fitting background for the moonlight meetings of little old dwarfs, or the gambols of woodland elves and goblins. •

The lichens are uniquely beautiful plants, but in addition they command our respect for their dauntless pioneering qualities. Without them, much of the earth's crust today would be as bare and lifeless, devoid of vegetation, as it was in those earlier geologic eras when plant life was beginning its colonization of the land.



BRYOPHYTA~ AND ~ ~ PTERIDOPHYTA

The HIGHER SPORE PLANTS—*Bryophyta* and *Pteridophyta*—are unassuming green plants which bridge the gap between the simple Thallus Plants and the complex Flowering Plants. Simplest of these complex Spore Plants are the Liverworts and Mosses—amphibians of the plant world; some with prostrate leafless bodies which cling closely to the moist ground, others with small slender stems clothed with leaf-like organs. More impressive in size are the Fern Plants, frequently dwellers in the damp and shade of cool forests and ravines; tropical representatives of which are the graceful and feathery Tree Ferns. Many of the species are a lingering remnant of once-powerful groups, plants with a glorious past when their ancestors dominated the land vegetation, a background for the first Amphibians and crawling Reptiles. The Fern Plants foreshadow the body plan of the Spermatophytes, developing a root system for absorption of water and minerals, a stem with adequate conductive channels, and a foliage of leaves especially constructed to manufacture food; in all these ways improving upon the conditions existing among the Thallophytes. In spite of these advances in vegetative complexity, the Fern Plants have not developed reproductive habits involving true flowers and fruits; this evolutionary advance came with the *Spermatophyta*.

CHAPTER VII

Amphibians of the Plant World



THERE are two well defined environments in which we find living things,—in the water and on the land. Each has its peculiar type of life, especially suited for the living conditions in its own particular habitat. Fishes are the most completely aquatic of all the backboned animals, while Reptiles and Mammals have become best fitted for terrestrial life. Bridging the gap between the two are the Amphibians such as frogs and salamanders. They begin their existence in the water as tadpoles but terminate their days on land; usually they live in swamps and along the margins of streams and lakes since they have certain reproductive and structural limitations which prevent their living far from any body of water.

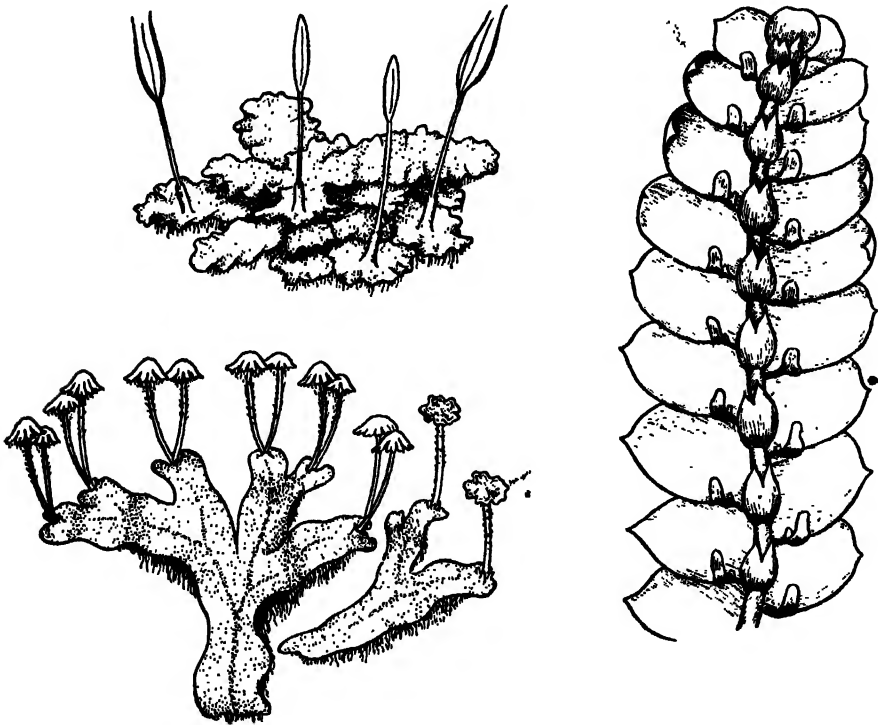
Among plants the Algae are best adapted for aquatic living and therefore dominate the vegetation of lakes and oceans. The Flowering Plants, on the other hand, have developed features which enable them to endure dry land living and, as a consequence, they form the dominant terrestrial flora. Bridging the gap between these extremes of plant life are the Mosses and their relatives which are found for the most part only in the damp environment of swamps, wet woods and along streams and ponds. For this reason, they can be considered the Amphibians of the plant world. These small green plants lack the root, stem and leaf structure which would permit them to live in more exposed and arid situations.

The moss plants and their relatives are included in the phylum *Bryophyta*. Here we find the simplest of the green land plants, far less complex than the Ferns or the Flowering Plants. Most of the Bryophytes are insignificant and unobtrusive plants, hiding away in the dimly lighted recesses of the woods and ravines. Some of them—the Liverworts—have a thallus-like body which forms a flattened growth similar to that of the crust-like lichens except for the distinctly green color. In the Scale-Mosses the prostrate thallus is differentiated into a stem-like axis and paired outgrowths similar to leaves. Both the Liverworts and the Scale-Mosses are considered a class of the Bryophytes known as the *Hepaticeae*. The true Mosses have gone beyond such a thallus condition and are characterized by a definite stem, usually erect and attached to the substratum by a basal tuft of root-like rhizoids. Growing radially on the stem are many small outgrowths, to all intents and purposes ordinary leaves to the casual observer. In addition to having these stems and “leaves”, mosses can be recognized

by their conspicuous spore-producing capsules which appear at the tips of the leafy plants. The mosses make up the other sub-group of the Bryophytes, technically known as the Musci.

THE LIVERWORTS

The natural home of the Liverworts and Scale-Mosses is in the shady retreats of the forests or on the damp walls of ravines and caves; frequently they cover the grassy hummocks and bases of trees in swamps with a dense green mat. Rarely do they venture far from the moist air of the dim woodlands. Their delicate bodies have little



HEPATICAЕ

Horned Liverwort (*upper left*), *Marchantia* (*lower left*), Scale Moss *Frullania* (*right*).

protection against loss of water by evaporation, and shrivel up when exposed to bright sunlight or dry air. Many species, however, show a remarkable ability to revive after long periods of desiccation, during which they appear dead.

A Liverwort is a flat ribbon-like plant of papery thinness; it may be long and slender, or repeatedly lobed and forked. The undersurface has numerous rhizoids which act as attachment organs, holding the thallus firmly to the earth, bark or stones on which the Liverwort is growing. Absorption of water, carbon dioxide and other food essentials takes place through the upper layer of cells or through special pores. Internally, the plant is very simple; the cells just beneath the upper surface



Liverworts such as *Conocephalum* form dense green mats on rocks, soil and fallen logs, preferring the moist shade of ravines and deep woods.

contain most of the chloroplasts and thus manufacture food for the plant, while the rest of the cells are colorless and act as storage tissues.

Few of the Liverworts have common names, the exception is the Horned Liverwort (*Anthoceros*), so named because the thallus produces reproductive structures in the form of long tapering stalks which rise like horns from the flat growing plant. *Riccia* is a simple little plant which grows by forking repeatedly, making green rosettes on damp soil. One species is aquatic and forms floating mats of slender, narrow thalli in ponds and reservoirs. *Pellia* is another of the prostrate species, distinctive in its curled and undulate margin; its pale green expansions cover moist rocks and earth. Most common of all is the coarser thallus of a *Marchantia* or a *Cono-*



MUSCI

Peat Moss (*left*), Rock Moss *Andreaca*, Luminous Moss

cephalum, with its strikingly different upper surface. This is divided into angular areas in the center of each of which occurs an air pore. These Liverworts may form dense mats on rocks, logs and soil at the edges of streams. During the reproductive cycle, the sex organs appear on umbrella-like structures which grow from the upper surface of the thallus. Beneath the edges of the "umbrella" the fertilized eggs develop into new plants.

The Scale-Mosses are also creeping, prostrate plants; but the thalli are differentiated into what may be called "leaves" and "stems" of a very primitive nature. The "leaves" are flattened, and often the plant has a distinct upper and lower surface, rather than the radial symmetry of the true Mosses. One of the commonest of the Scale-Mosses is the tiny *Frullania* which traces delicate patterns, brownish-green in color, on the bark of beech and birch trees. The diminutive "leaves" can best be seen with a hand lens. *Porella* is a larger plant, found on rocks and soil as well as the bark of trees, its "leaves" are deeply lobed, and the branches of the thallus, if the plant is growing on a vertical surface, grow outwards and curve upwards. *Bazzania* is a large and common Scale-Moss which forms a continuous green carpet on stumps and

fallen logs in swampy woods. The delicate "leaves" are generally toothed at the apex. In the pale green *Trichocolea* the "leaves" under a hand lens look like clusters of algal filaments for each is deeply lobed and branched into many hair-like subdivisions.

THE TRUE MOSSES

The true Mosses are Bryophytes. Many other plants are erroneously referred to as mosses; for example the Sea Mosses (Algae), the Club Mosses (Fern Relatives), Florida Moss (a Flowering Plant), and Reindeer Moss (a Lichen). A true Moss is a green plant with primitive stems and leaves, reproducing by spores in one phase of its life history. There is a variety of habitats from dry lichen-encrusted ledges to beds



MUSCI

Extinguisher Moss (*upper left*), *Mnium* (*lower left*), Crane's-bill Moss (*center*), .
Hairy Cap Moss (*right*).

of swiftly flowing streams, but most common shaded woods and ravines. Mosses are of considerable importance in soil building and prevention of erosion; for they conserve the moisture in the ground, prevent floods, and by the accumulation of humus aid in the colonization of the land. By gradually filling up the lakes and ponds, mosses are continually transforming many small bodies of water into land.

Mosses are predominantly small plants, at most a few inches high. This is due to the fact that they lack true roots and have no special conductive channels whereby materials can be transported through the plant efficiently enough to sustain a large

body. They generally grow in close association with one another, forming dense mats and carpets of vegetation. The "leaves" are only a cell or two in thickness, and therefore are not similar to the leaves of higher plants. The green moss plant reproduces sexually by producing eggs and sperm in special organs found at the tip of the plant. The fertilized egg remains in place and grows into a brown, parasitic plant which becomes tipped with a capsule in which the spores are produced. These spores are scattered by the wind, and when they land in a favorable location germinate into new green moss plants. During sexual reproduction, the sperm must swim to the eggs; this explains the dependence of these plants upon moisture, without which the sperm could not move from one place to the other.

Peat Mosses (*Sphagnum*) are a distinctive and economically important group of mosses. They are usually pale yellow-green in color, and are found so exclusively in swamps and bogs that they are also known as Swamp Mosses. The leaves are constructed to absorb two hundred times their weight in water; they have been satisfactorily used in surgical dressings, in place of absorbent cotton. The plants grow rapidly at their tips, leaving behind dead leaves still attached to the stems; the accumulation of these dead parts, with other plant debris, results in an organic deposit known as peat. Peat is rich in carbon and therefore is of fuel value. A pound of peat produces 9,400 thermal units as compared with the 13,600 in a pound of soft coal; on the other hand, peat has twice the heating value of wood. Peat deposits are a source of fuel in those countries where it is difficult to obtain coal or wood, being used especially in Ireland and the Scandinavian countries. Dried Peat Moss when ground is used in garden cultivation, and is used also as a packing by florists. The only other moss of a similar, whitish hue is the Pin Cushion Moss (*Leucobryum*) which forms hemispherical cushions at the base of trees in damp woods. The compact habit of the closely growing Pin Cushion Mosses is very different from the loose and spongy mass of *Sphagnum* plants, as is the land dwelling habit of the former in contrast to the submerged condition in which the Peat Mosses are usually found.

Some of the Mosses can be recognized by the characteristic fashion in which the leaves grow in two flattened rows, after the fashion of the Scale-Mosses. *Fissidens* is a small moss, a few inches in height, with the leaves thus in pairs, in the same plane. It is common on moist soil and stones in shaded places. *Schistostega* is another moss with the leaves arranged in this way; it is a rare plant, found hiding away in the dark crannies of caves and underneath logs. It is known as the Luminous Moss, due to a golden-green glow (similar to the color of cat's eyes in the dark) which seems to come from the ground beneath the tiny plants. The reason for the glow is that the filamentous root-like portions of the moss have refractive cells which shine by the light coming into the cave or dark hole. It is not luminescent in the same way that many of the fungi are.

A few of the mosses are dark brown to black in color, especially when dry. *Andreaca* is a crisped-black plant whose brittle leaves are densely matted together; it is a plant of alpine habitats, growing on granite or slate rock outcrops. The famous Old Man of the Mountains, in New Hampshire, supports a luxuriant growth of this little moss. Likewise growing on rocks are the dark tufts of *Hedwigia* and *Grimmia*, the former characterized by whitish leaf tips. The latter is the only one of these dusky colored mosses found on trees; it can be recognized in its reproductive condition by



Peat Moss (*Sphagnum*) leaves can absorb two hundred times their weight in water, and have been used in place of absorbent cotton; they form pale green spongy mats in bogs and swamps.

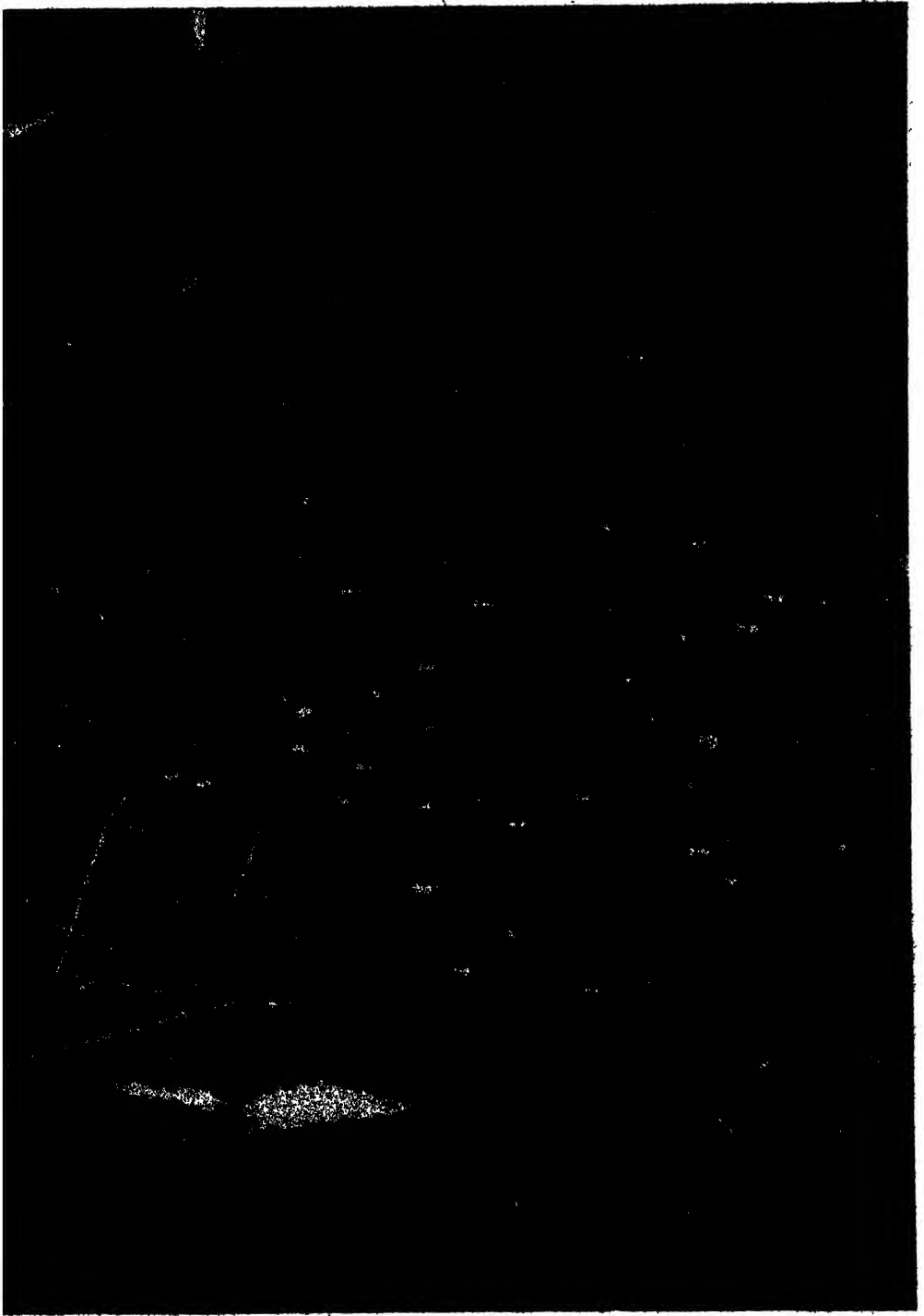
the hairy covering to the spore capsule, in contrast to the smooth capsule of the other black rock mosses. All of these genera can become so dry that they crumble in one's fingers, yet they retain enough vitality to spring into new life as soon as they are moistened by mist or rain.

The remaining mosses can be separated into two groups on the basis of their habit and method of producing spore capsules. In one group the plants grow more or less erect and develop capsules on stalks which terminate the stem. In the other group the plants are creeping and the capsule stalks grow out laterally from the main stem.

Among the erect mosses with terminal spore capsules we find the Hairy Cap Moss (*Polytrichum*), also known as Bird Wheat or Pigeon Wheat; it is a coarse, rank-growing plant reaching a height of four to six inches. The hairy covering of the spore capsule gives it its name. This moss is a common sight in pastures, fields and woodlands; because of its ability to drive out grasses, it is considered a pest by the farmers. There is also the Crane's-bill Moss (*Dicranum*) another common moss, one of the most beautiful of the woodland genera. A lustrous yellow-green in color, the Crane's-bill Mosses form thick mats on soil, stones and around the base of trees. The beaked capsules on long stalks resemble heron's bills. The Extinguisher Moss (*Encalypta*) has rather large tongue-shaped leaves; it is a small plant, about an inch in height, common to the limestone rocks of mountainous regions. The covering of the capsule extends below it, looking like an old-fashioned candle extinguisher. *Bryum* is broad-leaved and very green, a moss of real beauty—especially one species whose erect stem is leafless except at the summit where it bears a rosette of leaves. From the center of the rosette there grows the stalk with its drooping spore capsule. It grows profusely on the rich soil around the roots of trees, in shaded and moist woodlands. *Mnium* is a plant of similar general appearance; its delicate glossy green leaves are so thin that they are translucent. This moss quite often forms bright green beds in the swampy ground surrounding woodland springs.

The creeping mosses with capsules on the side of the main stem include many of the most showy of the woodland species. Because of their prostrate way of growing they frequently cover entire logs and ravine banks. Such are the Fern Moss, Plume Moss and Tree Moss. The Fern Moss (*Thuidium*) is fragile and like a fern in appearance; it prefers to grow in the damp shady places, on stones, earth and logs. The Fern Moss branches in a symmetrical manner, and the branches in turn are subdivided into smaller branches; the leaves themselves are very small. The Plume Moss (*Hypnum*) is also appropriately known as the Feather Moss. Its flattened branches, looking like the sprays of some miniature evergreen tree, cover logs and stumps in the cool woods with raiment of deep green. The Tree Moss (*Climacium*) is a larger and more robust plant, often confused with the Running Pine (*Lycopodium*) which is one of the Fern Plants. The erect tree-like shoots form dark green clumps on the damp earth in woods and swamps. The Tree Mosses are the giants of the Bryophytic world,—yet they attain a stature of but six inches.

The Water Moss (*Fontinalis*) is one of the creeping mosses which lives entirely submerged throughout its life; it is common in streams and ponds, but is never found in stagnant water. The branches are long and slender, covered with scale-like brownish-green leaves.



Hairy Cap Moss (*Polytrichum*) is a common plant of open fields and pastures; the plants in this photograph have not yet produced the brown spore-capsules of the asexual generation.

These are but a few of the hundreds of species of mosses and liverworts which abound in our woods and meadows. Even if unable to recognize many of them by name, one will find a new pleasure in rambling through the cool ravines and the Sphagnum-filled bogs when one can pick out, from the luxuriant tangle of plant life, these dwarf members of the land flora who still cling to the moist habitats through which plants had to migrate in their evolution from aquatic to terrestrial existence. We see in the Bryophytes those plants which are only partially adapted for living on dry land ; hence they are most commonly found in wet woods and swamps, or along the margin of ponds and streams.

CHAPTER VIII

The Fern Plants



ALTHOUGH the six thousand species of true Fern Plants are widely distributed over every continent and in every climatic zone, they attain their greatest luxuriance and size in the tropical rain forests of Ceylon, New Zealand and Brazil. In the cooler temperate regions, representatives of most of the fern families exist as a flora well adapted to the cooler climate, provided it presents sufficient atmospheric moisture and not too intense illumination.

The majority of ferns are larger than the Bryophytes but smaller than the woody Flowering Plants—their size in temperate regions rarely exceeding five or six feet. In the tropics there are tree species which attain a height of forty feet. Ferns are, for the most part, terrestrial plants rooted in the earth; but in warmer countries a great many grow upon other plants, often upon tree trunks. Such plants which live upon other plants but do not absorb nourishment from them are known as epiphytes. There are, finally, a few ferns which have adopted the water as their home and live floating or submerged in ponds and lakes.

The ferns are significant as a group in that they are the simplest plant phylum to have developed a system of conductive channels in the stem for the transportation of food, water and dissolved minerals throughout the plant body. If plant stems were limited to the types found in the seaweeds, liverworts and mosses, our land flora would be an inconspicuous assemblage of tiny plants restricted to the borders of swamps, streams and ponds. It is in the ferns that we find, for the first time, competent tissues for the intake of water and dissolved minerals from the soil through a true root system. In the ferns, too, the leaves have become efficient organs for the manufacture of food by the specialized chlorophyll-bearing cells. The stems of most ferns are horizontal subterranean structures known as rhizomes from which a few large leaves are pushed upwards through the ground each season. The leaves themselves vary in size and appearance but, as a rule, are large and intricately subdivided.

Ferns do not reproduce by flowers; this is the chief distinction between them and the highest group of plants, the Flowering Plants. Instead they produce organs known as sporangia, small sacs corresponding to the spore capsules of mosses; each sporangium is filled with thousands of minute spores, each capable of germinating independently into a new plant. Groups of these sporangia may appear as brown dots

on the under surface of the leaves or clustered in berry-like masses on special stalks.

Ferns are rarely found by those whose nature instincts can be satisfied by reclining on the seat of an automobile or by following well-beaten paths. Of course there are a few common species which have adapted themselves to roadsides and meadows; but the majority are modest and retiring by disposition, hiding away in the recesses of the forest where only those may find them who have the perseverance to search arduously in the hope of discovering a rare plant. They are associated with solitude, dimness and the earthy fragrance of damp woods. In such places, far from the bustle of the sunlit world, ferns grow frequently in luxurious abandon, their delicate fronds characterizing the peacefulness of their existence.

Ferns belong to one of the smallest phyla of the plant kingdom known as the *Pteridophyta*. As has already been pointed out, they have true roots, stems and leaves but no flowers. Reproduction is a rather complex process involving an alternation of two separate generations, one reproducing sexually and the other asexually. The ordinary green fern plant reproduces asexually by forming the minute spores; each spore germinates, not into a new leafy fern plant, but into a small thallus hidden among taller plants and rarely seen by the average person. These thallus plants are known as gametophytes because they reproduce sexually by gametes (i. e., eggs and sperm). The gametophyte of a true fern is a heart-shaped plant often smaller than a dime, and on it are produced the sex organs which give rise to swimming sperm which fertilize the eggs on the same plant. Each fertilized egg grows into a leafy green plant which is commonly thought of as the fern. Because of this dependence upon swimming sperm, the full life cycle of a fern is restricted to shaded locations where there is sufficient dew or other moisture for swimming sperm cells. By propagating themselves vegetatively, eliminating the gametophyte phase, some hardy species have adapted themselves to arid regions.

The Pteridophyte group is made up of four classes of living fern plants, only one of which—the True Ferns—will be considered in this chapter. Each of these classes includes many fossil and extinct species as well as living ones. In fact the fern plants were the first types of vegetation to colonize the land, many of them forming the first forests. In addition to the True Ferns, there is the relatively small group of the Psilotum plants—unusual rootless or leafless tropical plants; the group of the Horse-tails and Scouring Rushes with segmented stems and small functionless leaves in whorls; and the group of the Club Mosses and Creeping Pines with small evergreen leaves on short or creeping stems. These allies of the true ferns will be described in the following chapter. The True Ferns (*Filicineae*) are an assemblage of some fourteen families, many of which are chiefly tropical in their range; the following includes species common in the United States.

THE POLYPODY FAMILY

In the Polypody Family (*Polypodiaceae*), the largest family of ferns, we find the majority of the common species. Characteristic are the leaves, usually intricately subdivided into leaflets (pinnae) and smaller pinnules, with the sporangia for the most part produced on the under side of the leaves. The fertile leaves are hardly different from the sterile ones on which there are no sporangia. The plants in this family vary in size from the tiny Cliff Brakes to the tall Brakes and the attenuated Sword



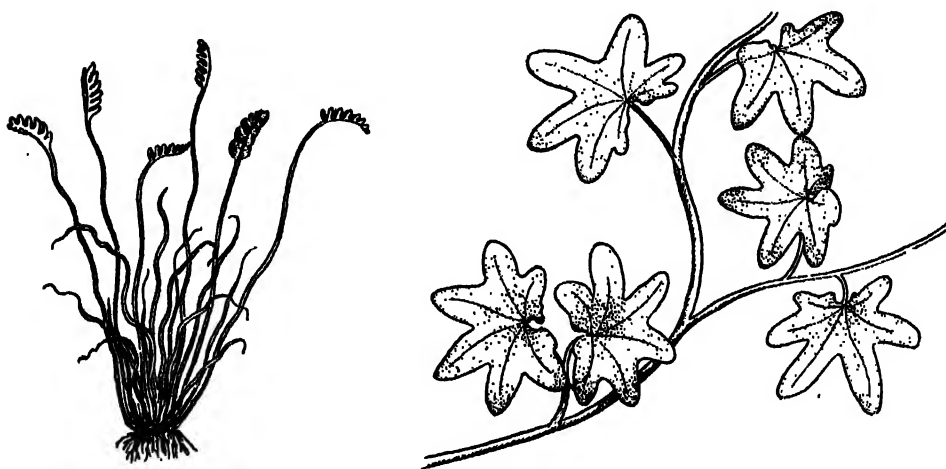
POLYPODIACEAE

Upper Row: Boulder Fern, Maidenhair Fern, Cliff Brake, Ebony Spleenwort.
 Lower Row: Marginal Shield Fern, Walking Fern, Sensitive Fern.

Ferns. Although most of them are at home in the shadowy depths of the woods, some have ventured beyond the borderline of thickets and open woods to adapt themselves to the sunnier, drier habitats of fields and roadsides.

Two of the ferns in this family are common to grassy fields, dry banks and roadsides, as well as being found in the open glades of woodlands. They are the Lady Fern and the Hay-scented Fern. Both have clustered fronds which grow two to three feet in height, each leaf subdivided into feathery frond.

The Hay-scented Fern (*Dennstaedtia*) can be recognized by the clusters of sporangia partially hidden under the recurved teeth of the leaflets. Although all ferns have a characteristic "ferny" fragrance, especially when bruised or crushed, in this genus it is particularly noticeable. The plants grow close together forming solid banks of delicate foliage along the roadsides, of a light or yellowish green. This fern is very



SCHIZAEACEAE

Curly Grass and Climbing Fern.

sensitive to the cold and is one of the first ferns to wither and turn brown at the early frosts.

The Lady Fern (*Athyrium*) differs from the Hay-scented in that the sporangia occur in crescent-shaped groups on the under side of the leaflets. It is not restricted in its range to northeastern United States, as is the case with the Hay-scented Fern, but extends throughout the temperate parts of the northern hemisphere. The name Lady Fern is of ancient origin, dating back to the time when this plant was supposed to produce the mystic fern seed which made its possessor invisible. Another fern of similar potency was dubbed the Male Fern. The mystic powers of each fern were efficacious only when used by the proper sex.

The Brake Fern (*Pteridium*) is the most widely distributed of all the ferns. In Britain it forms a conspicuous feature of the landscape, as every traveler over the moors and heaths well knows. It is one of the commonest of American ferns, found everywhere in open woods but growing more thickly in the zone between meadow and woodland where the low thickets give partial shade yet admit some direct sunlight. The stems



Christmas Fern (*Polystichum*) lacks the delicacy and airiness of other ferns, looking the part of the rugged individuals they are, capable of remaining green amid snow-covered rocky hillsides.

are coarse and erect, reaching a height of four or five feet and then branching into three quite distinct sections each bearing a subdivided leaf. The leaf spread averages several feet; individuals from Ireland are recorded which reach a height of thirteen feet with a correspondingly great spread. This fern generally indicates poor and barren soil. Numerous superstitions surround this fern: some say that it is a protection against goblins and witches because of the initial of Christ upon its root—a vague letter C being formed by the vascular tissues. This same figure in the cut stem gives the impression also of a spreading oak tree; the more perfect this impression, the luckier he who finds it. It is one of the few fern species of any practical value, being used as a packing for fruits and vegetables since it prevents mildew and decay. When the young ferns first push their heads above the ground in early spring, they are curled up as “fiddle-heads” which are tender enough to be eaten as a delicacy.



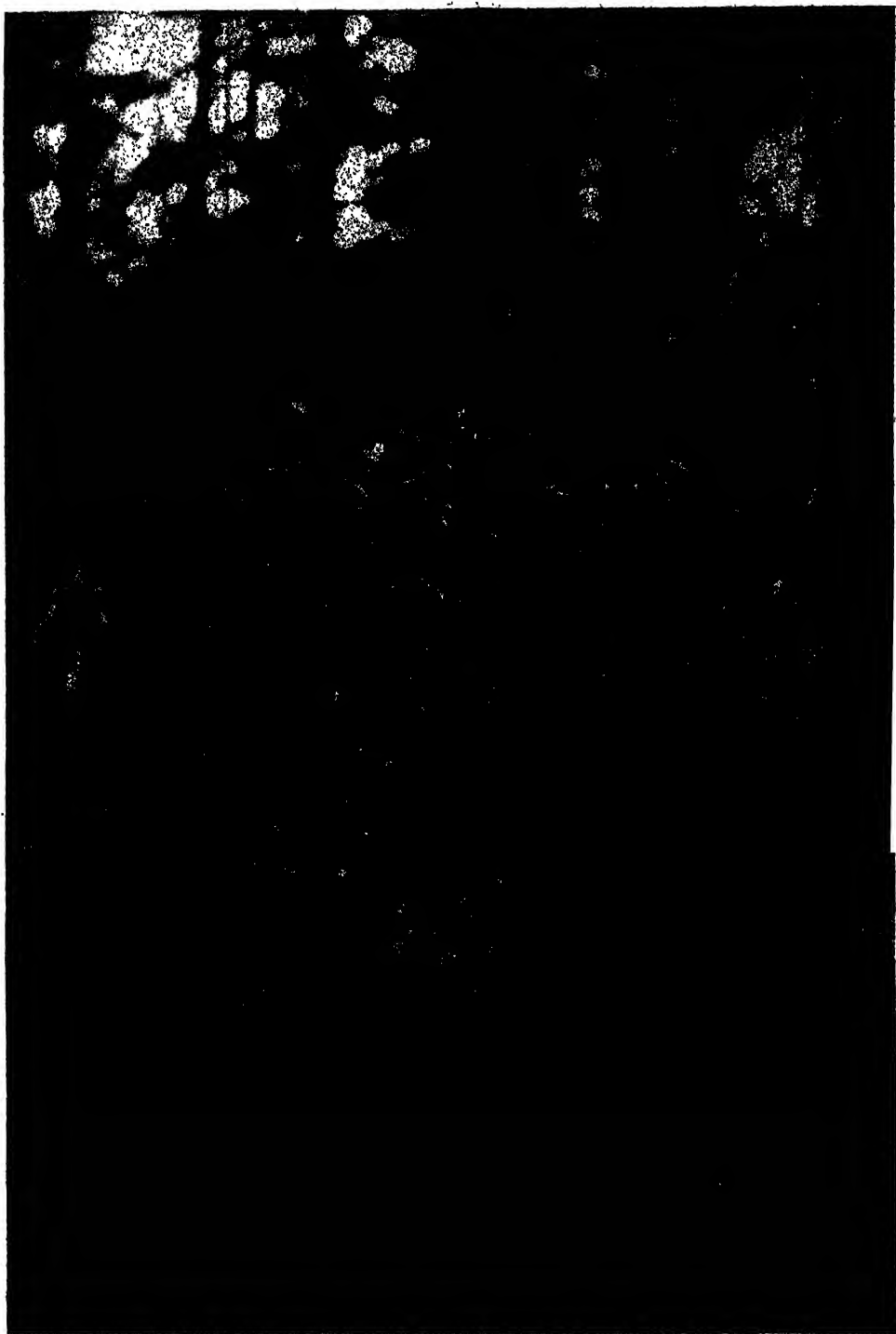
OTHER PTERIDOPHYTES

Filmy Fern; *Selaginellaceae*: Spike Moss; *Isoetaceae*: Quillwort.

A giant Brake Fern (*Litobrochia*), common to the Old World tropics, grows in the hammocks of southern Florida.

It is in the dusky shadows of the woods that most of the Polypody Family are found. Shaded and rocky banks, sides of ravines, entrances to caves, slopes leading to streams, ledges beneath waterfalls—all have their special fern inhabitants. In the arid southwest, a few of them hide beneath the rocks and cliffs, others retreat to the shade and moisture of the mountain canyons. In the tropical vegetation found in southern Florida, they form aerial gardens as epiphytes on the trunks of the trees.

The Maidenhair Fern (*Adiantum*) is a widely spread and well-known fern. Its fragile branched frond bears small lobed leaflets which closely resemble those of the Meadow Rue. All but five of the species of *Adiantum*, which includes over one hundred and seventy species, are tropical; the northeastern Maidenhair has a western counterpart living among the Pacific coast mountain ranges, and a southern relative known as the Venus-hair Fern, ranging from Florida to California.



The Boulder Fern (*Polypodium*) is an evergreen fern, often completely covering rocks and tree trunks with a mantle of green fronds.

The Wood Ferns (*Dryopteris*) have fronds subdivided into leaflets, many of the fronds being evergreen. The Marginal Shield, or Evergreen Wood, Fern is an inhabitant of rocky ravines of the northeastern states; its leaves are a rich dark green, pale beneath; the lower portions of the leaf stalks are often covered with a shaggy mass of buff-colored scales. The Crested Shield Fern is another species which prefers low boggy ground such as is found in swampy thickets where it associates with Skunk Cabbage and Marsh Marigold. The tall, erect fronds have finely toothed margins with the sporangia clustered towards the center of the leaflet rather than at the margin.



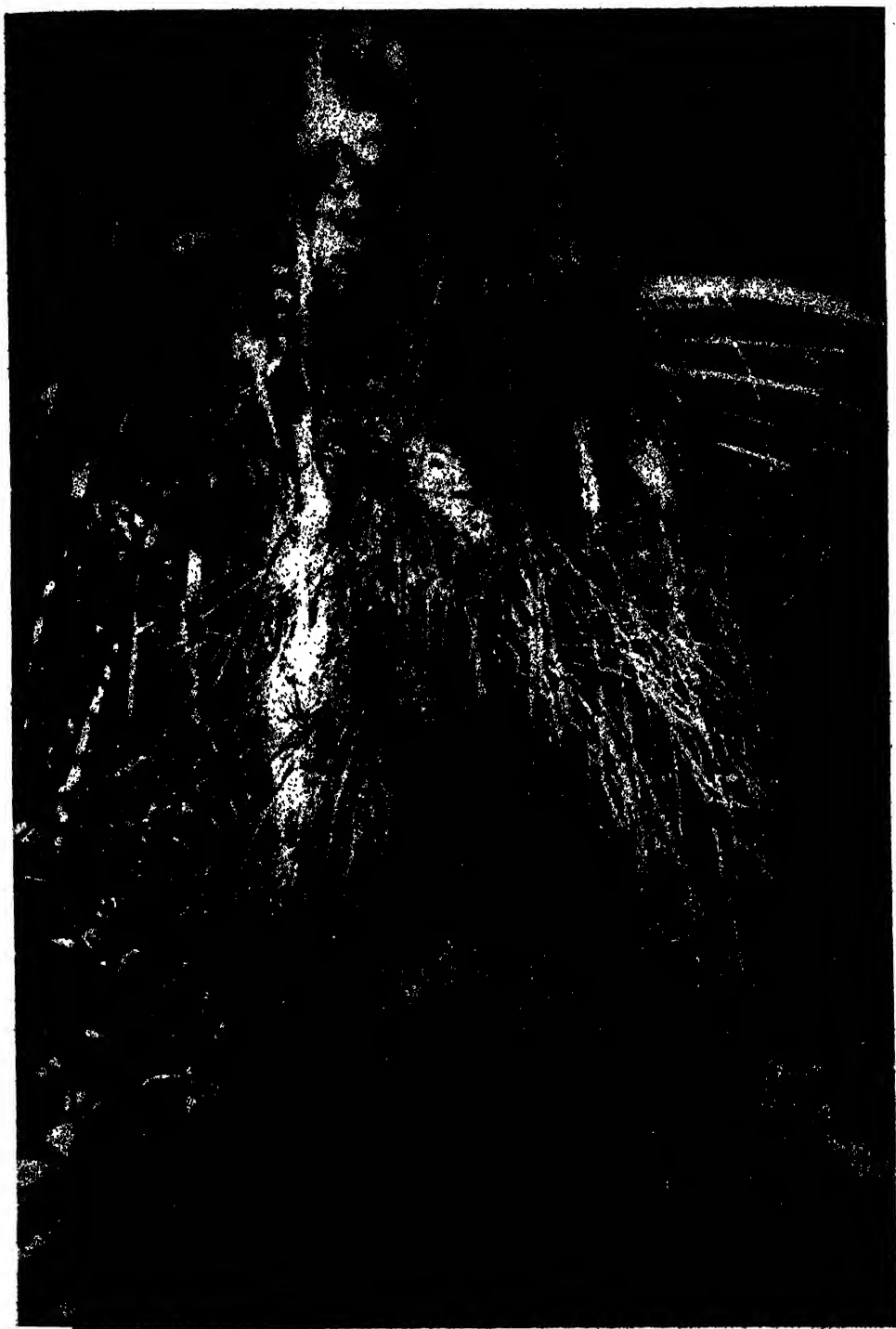
OPHIOGLOSSACEAE

Adder's Tongue, Rattlesnake Fern.

differing in both these respects from the Marginal Shield Fern. One of the several tropical species found in Florida attains a length of eight feet. In the mountains of the west we find the related Downy Wood Fern, Sierra Wood Fern, Mountain Wood Fern; and on the Pacific coast, the Coastal Wood Fern.

The Beech Fern (*Phegopteris*) is a member of the fern flora which ranges from Washington and Oregon to the Atlantic coast; in the east it prefers the vicinity of dripping rocks and the rich soil of deciduous woods. The short broad fronds are triangular in outline, and the basal leaflets have a habit of turning outwards like a pair of horns.

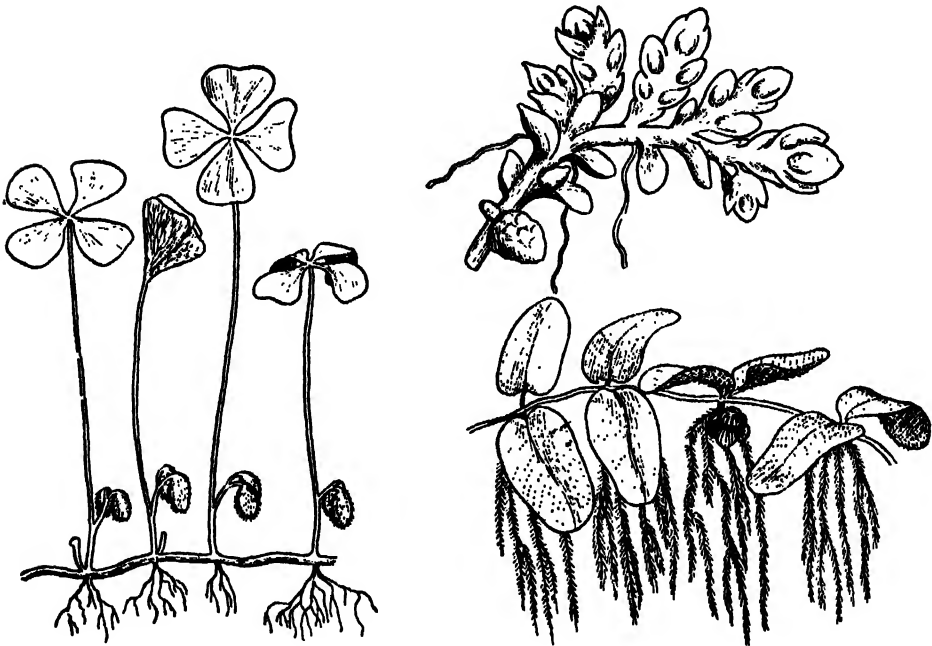
Among the smaller ferns is the frail little Oak Fern—another species of *Phegop-*



The narrow pendant grass-like fronds of the Shoestring Fern (*Vittaria*) frequently completely cover the trunks of Cabbage Palms in Florida.

teris—whose fronds are miniature copies of the three-parted ones of the Brake. The whole Oak Fern is often hidden under a mass of dry leaves and twigs.

The Christmas Fern (*Polystichum*) of the east is an evergreen plant with long, tapering fronds which are coarse in texture and dark green in color. This sub-arctic member of the Polypody family grows on rocky snow-covered hillsides otherwise barren of plant life. Christmas ferns lack the delicacy and airiness of the other ferns, looking the part of the rugged individuals that they are. Other species of *Polystichum* live among the western mountains, being known as Holly Ferns, Western Sword Ferns and Shield Ferns.



MARSILIACEAE AND SALVINIACEAE

Pepperwort, Floating Fern (*upper right*), Floating Moss (*lower right*).

The preceding species of the Polypody family have been partial to grassy fields or the humus-covered floor of the forests. There are many other species which are inseparably associated with rocky cliffs and ledges which constitute their favorite haunts.

In northeastern United States the commonest of all the rock-inhabiting ferns is the little Polypody or Boulder Fern (*Polypodium*) whose creeping stems frequently completely cover rocks and trunks with a green mantle. The fronds, being evergreen, are especially conspicuous in winter. Each frond is narrow, tapering, and like a small Christmas Fern but unique in the fact that the leaflets are attached to the midrib of the frond by their entire basal portions. In the southern states, a related species is the Resurrection Fern which covers the trunks of giant oaks, gumwoods and palms with a brownish mass of curled fronds in dry weather; in damp weather these apparently



The Royal Fern (*Osmunda regalis*) looks like a bushy flowering plant, with its branching stems and numerous elliptical leaflets; its roots are often in the clear water of streams and pond margins.

dead plants come to life and assume a greener hue. Another epiphytic fern of Florida and near-by states, found on palm trunks, is the Golden Polypody or Serpent Fern.

The Cliff Brakes (*Pellaea*) usually have stiff, low-growing fronds with firm leaflets looking like some small flowering plant. In the east, some species show a preference for limestone regions. The Cliff Brakes are among the few ferns which have adapted themselves to the dry environment of the southwest, where we find the Desert Cliff Brake, the Coffee Fern and the Bird's Foot Cliff Brake.

The Spleenworts (*Asplenium*) are, for the most part, also low-growing ferns of rocky ledges. The Elxony Spleenwort is a graceful little plant with a basal rosette of small leaves surrounding a cluster of a few erect and taller ones whose stems are conspicuously purplish black. It is a northern species tolerant of a variety of habitats including roadside banks, sand dunes and rock slopes. The Maidenhair Spleenwort, as the name suggests, resembles the Maidenhair Fern in the shape of the leaflets; the plant itself however is much smaller and grows in tufted masses. It grows as commonly on the Pacific coast as in the eastern states. The Silvery Spleenwort is a larger fern, resembling a Lady Fern, but being less lacy in appearance.

The Walking Fern (*Camptosaurus*) is a rare plant of limestone areas, ranging from Canada to North Carolina. The clusters of tapering, tongue-like fronds, not divided into leaflets, form a tangled growth over rocks and boulders. Aside from the customary method of fern reproduction, this species forms new plants in a manner all its own. Each leaf terminates in a slender tip which, arching over, may root in the substratum and there grow into a new fern plant. The tiny new plant, with its own cluster of leaves and roots, in time separates from the parent leaf tip. This novel method of reproduction has given the fern its name. In similar locations one may find an even rarer fern, the Hart's Tongue (*Scolopendrium*) with the same linear, strap-shaped leaves but without the unique method of reproduction.

The Sensitive Fern (*Onoclea*) is a common fern of northeastern United States, partial to a variety of habitats but preferring wet sunny fields and the border of ditches. The light-green fronds are not divided into leaflets, but lobed deeply; the sporangia are born on modified fronds in the center of the cluster of sterile green ones.

Some members of the Polypody Family are common also in the desert and mountainous parts of western United States, as we have already seen. In addition there are the Lip Ferns and Lace Ferns (*Cheilanthes*), the woolly and hairy Cloak Ferns and Cotton Ferns (*Notholaena*), the Gold Fern (*Pityrogramma*) and the Parsley Fern (*Cryptogramma*). Many of these have stiff wiry stems and fronds with leaflets that roll up tightly in hot dry weather. Since in many of these species the under surface is densely covered with brown hairs, the curled up fronds have a rusty and fuzzy appearance.

In the hot, humid regions, such as Florida, many of the Polypody Family form a part of the luxuriant tangle of air plants which cover the tree trunks. At the base of the palms, sometimes partly up the trunks, grow clusters of the undivided fronds of the Strap Fern (*Camphyloneurum*), while the Resurrection Ferns (*Polypodium*) cover the sloping upper portions of the trunk. The narrow, grass-like fronds of the Shoe-string or Grass Fern (*Vittaria*) form bunches of pendant dark-green along the trunks of the Cabbage Palms. In Florida also, the palm jungles of the hammocks include a



Cinnamon Fern (*Osmunda cinnamomea*) forms graceful vase-shaped clusters of arching fronds which surround the central cinnamon-brown reproductive ones.

dense undergrowth of Sword Fern (*Nephrolepis*) which sends their tapering, slender subdivided fronds climbing upwards with the aid of the stems of other plants, often attaining a length of ten feet. Another species, found from Florida south to Brazil, is the common Boston Fern.

THE ROYAL FERN FAMILY

The Royal Fern Family (*Osmundaceae*) includes some of our most conspicuous ferns. In the Polypody Family the sporangia are generally formed in clusters on the under side of green fronds which look like ordinary leaves. In the Royal Fern Family, on the other hand, the sporangia are clustered on special fronds which look very little like the ordinary leaves.

The Royal Fern (*Osmunda*) is often called the Flowering Fern because of its similarity to a flowering plant. The branched stems bear oval or elliptical leaflets which are not at all fern-like in appearance. The stalks, with their sporangial clusters, look as if they were covered with small brown berries. The Royal Fern is common in Europe, the United States, Mexico, South America, Asia and Africa. It is commonly found with its roots in the water, forming a bushy growth four or five feet tall in swamps and along the shores of lakes and streams. In the Everglades of Florida this fern is very common, forming dense thickets acres in extent, with individual tussocks of the Royal Fern attaining a height of six feet.

The Cinnamon Fern (also an *Osmunda*) is also common in North and South America as well as in Europe and Asia. This swamp-dwelling fern can at times be found also in wet woods and meadows where it forms graceful vase-shaped clusters of stiff green fronds, each subdivided into smaller leaflets. The circle of foliage fronds surrounds the erect, smaller reproductive ones which are cinnamon-brown in color due to the presence of the sporangia.

The Interrupted Fern (*Osmunda*) has foliage fronds similar to those of the Cinnamon Fern—tall coarse leaves subdivided into leaflets. It likewise grows in similar habitats. When reproducing, however, there is an obvious difference; for part way down the stem the Interrupted Fern produces several sets of fertile leaflets which become twisted brown structures covered by sporangia, interrupting the growth of the sterile green fronds, which continue along the stem above and below these reproductive ones.

THE CURLY GRASS FAMILY

Most of the plants we have already considered have the feathery fronds typical of ferns. The Curly Grass (*Schizaea*) however would never be recognized as a fern by the casual naturalist because of its long, thin, grass-like leaves. The Curly Grass is an inconspicuous wiry little plant, only a few inches high and therefore usually hidden by the surrounding vegetation. Its chief interest lies in its peculiar distribution. It is a rare fern limited to the sand barrens and cranberry bogs of New Jersey; elsewhere it has been collected only in Newfoundland and Nova Scotia. Such unusual distribution has made it a lure for botanists ever since it was first discovered in New Jersey in 1815.

The Climbing Fern (*Lygodium*) is also in the Curly Grass Family (*Schizaeaceae*). Very different in habit and distribution from the Curly Grass, this uncommon



Interrupted Fern (*Osmunda Claytoniana*) produces several fertile leaflets, covered with sporangia, in between the sterile green foliage portions of the frond

fern is in reality a climbing vine with rounded and lobed leaves much like those of the ordinary ivy. The Climbing Fern is a rare fern of moist woods from Massachusetts southward. It has the unique distinction of being the only fern for which a special law has been passed. Once common in the vicinity of Hartford, Connecticut, reckless picking threatened its existence. To save it from extinction, a law was passed in 1869 by the Connecticut Legislature. Since it was also known as the Hartford Fern we can understand the solicitude of the Connecticut lawmakers in giving the plant official protection.

THE FILMY FERNS

There are in the tropics a great number of species belonging to the Filmy Fern Family (*Hymenophyllaceae*) which is characterized by particularly small and delicate fronds. A few members of the family, none of them very common, are found in our southern states. The Killarney Fern (*Trichomanes*) is found in the region from Florida northward to Kentucky, where it lives on ledges under overhanging moist cliffs. The fronds of some species are long and narrow, others subdivided into leaflets. Another species, restricted to Alabama, is a minute creeping plant with small oval leaflets. It hides under vegetation on dripping cliffs and is so diminutive that a coin will cover an entire colony of plants.

THE ADDER'S TONGUES AND GRAPE FERNS

More succulent and fleshy than most ferns are the members of the Adder's Tongue group (*Ophioglossales*). They are low-growing plants of swamps and other wet places, each consisting of a single leaf which may be entire or subdivided, with an erect fruiting spike growing from the leaf stalk. Some of the species are ground-dwelling plants, others grow upon tree trunks as epiphytes.

The Adder's Tongues (*Ophioglossum*) have oval or pointed undivided leaves. The leaves are usually hidden among a tangle of grasses, the brown cone-like fruiting spike alone disclosing the presence of the plant.

The Moonwort Fern (*Botrychium*) is a plant of shaded woods where the soil is dark and rich. The single large triangular leaf is subdivided much as a Brake frond into three main divisions, each again divided into leaflets. It is found throughout the United States from British Columbia and Labrador to Mexico and Florida.

The Grape Fern is another species of *Botrychium*, also fleshy with erect compound leaves which appear much later in spring than those of the Rattlesnake Fern, which they closely resemble. One of the Grape Ferns is evergreen. Though there are twenty or more species in this group, abundant in temperate regions, only a few are common in the United States.

THE WATER FERNS

Even though ferns are considered water-loving plants, they usually prefer to grow on wet soil rather than actually in the water. The nearest approach to an aquatic mode of life is found in the Water Ferns (*Hydropteridales*) which are represented by the Pepperwort, the Floating Fern and the Floating Moss.

The Pepperwort (*Marsilea*) is a small plant rooted in the mud of shallow ponds.



The Stag-horn Fern (*Platyceium*) grows as an epiphyte upon the trunks of Palms and other tropical trees, special basal leaves being adapted for the collection of water and humus.

usually growing partly submerged. Leaves are similar to those of a four-leaved clover. Of some fifty species, only four are known to exist in the United States; these are restricted to the southern states, only a few having become naturalized in our northern areas.

The Floating Fern (*Azolla*), as its name implies, floats on the surface of ponds rather than roots in the mud. The plants are very small and moss-like, with minute fleshy and lobed leaves. They reproduce so rapidly by vegetative methods that the plants soon cover the entire water surface with a dense mat of vegetation which varies in color from green and brown to red depending upon the amount of sunlight to which it is subjected. Because it grows so densely, the fern is used in mosquito control. Introduced into ponds where mosquitoes breed, the mat of plants prevents the larvae from coming to the surface to breathe. It has been used for this purpose in New York, New Jersey, Germany and Panama.

The Floating Moss (*Salvinia*) is a larger plant than *Azolla*, with the same habit of forming a dense covering of vegetation over the surface of the water. The leaves, of a deep green color, are elliptical and somewhat resemble the common Duckweed (a Flowering Plant). The dozen known species are mostly tropical, with few representatives in the temperate flora. The leaves are roughened with many small spiny projections on the upper surface and are very hairy on the underside. What appear to be roots are in reality many finely dissected leaves which aid in the absorption of water.

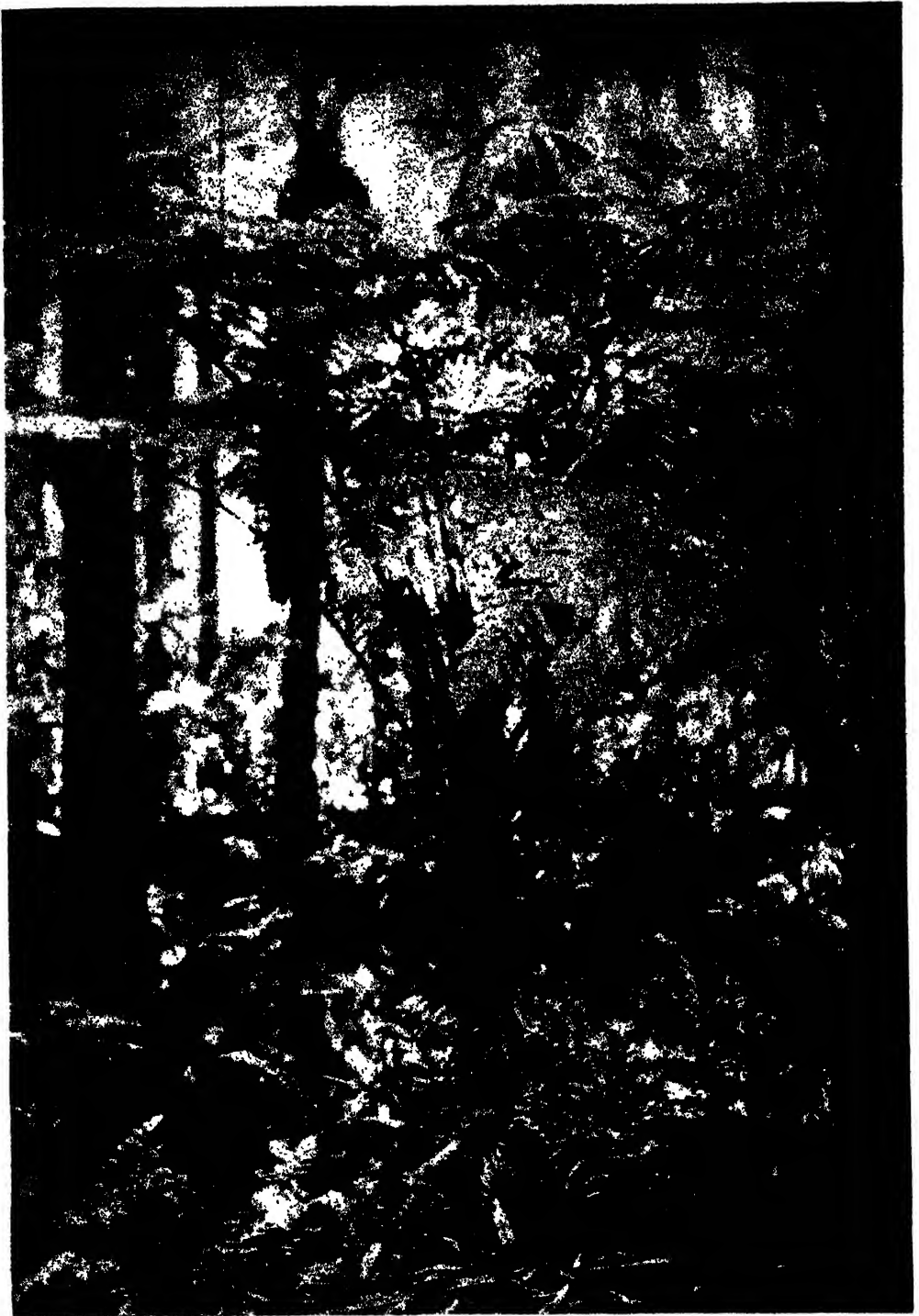
TROPICAL FERNS

In the tropical regions where there is heavy rainfall, ferns reach a luxuriant development. Many live as epiphytes on the trunks and stems of other jungle plants, their leaves often being specially adapted for collecting water and humus. The Stag-horn Fern (*Platycerium*) has rounded, closely overlapping, basal leaves which act as receptacles for collecting the organic material which is essential for the existence of a plant which has no roots in the soil.

Most magnificent of the Pteridophyta living today are the Tree Ferns (*Cyatheaceae*). They are a declining race, restricted to the humid tropical regions of Australia, New Zealand, Hawaii, Ceylon, Central and South America. Some of the finest groves are found on the cloud-bathed slopes of the Hawaiian mountains. Their appearance is graphically described by Vaughan MacCaughy:

"A fern forest has an inimitable charm and a distinctive beauty. In architecture and atmosphere, it is unique. There is no other forest canopy that feathers the blue sky with such noble fretwork. Its plummy frond spray is an incarnation of the humid air, the gentle breezes, and the tranquil filtered sunshine of its environments. There are no noisy wind-tossed leaves upon its velvet aisles; there are no crackling twigs to startle the wanderer in these green lit corridors. The sweet notes of the i'iwi bird tinkle bright as sunbeams through the fern domes; the brilliant scarlet of its plumage contrasts pleasingly with the great green feathers of its home."

A common Hawaiian Tree Fern (*Cibotium*) has a spongy brown trunk, about two feet in diameter and twenty feet tall; the exterior is often covered with a coarse matting of aerial roots which mingle with the fibrous matter of the stem. The upper portion of the trunk is armored with old persistent leaf-stalk remnants. At the top of the unbranched trunk is a canopy of subdivided feathery leaves often ten feet in length,



The tropical Tree Ferns (*Cyatheaceae*) are the most magnificent of living Pteridophytes, with huge feathery fronds clustered at the top of slender trunks.

giving a palm-like aspect to the tree. A Norfolk Island Tree Fern (*Alsophila*) reaches a height of eighty feet.

The base of the leaf stalks and the buds are densely covered with golden brown hair, known as "pulu" which is exported as stuffing for pillows and mattresses. The "pulu" of the Javanese *Dicksonia* is exported to Europe where it is used as a surgical styptic. This woolly product of the Tree Ferns gave rise to one of the most fanciful legends about plant life, known as the Scythian Lamb. According to the mediaeval botanists, this wonderful creature was a strange combination of wool, flesh and blood; a root connecting its navel with the soil. The creature was said to resemble a lamb, but grew on a stalk about a yard high, on which it turned about, feeding upon the vegetation within reach. When this was all consumed, the poor creature died. In 1725 an enterprising student at last actually examined one of these "lamb" and discovered that it was only the rhizome of a large fern, covered with "pulu".

Today the chief use of the Tree Ferns is as a starchy food (secured from the trunk) fed to swine and as a material for building corduroy roads through tropical swamps.

And so we take leave of the Ferns, that group of plants which in all features except the presence of flowers are much like the phylum of the Flowering Plants. But before we progress to this latter group, it will be well worth our while to become acquainted with the various Fern Relatives which form the subject matter of the next chapter.

CHAPTER IX

Fern Relatives, Past and Present



CLOSELY related to the True Ferns and grouped with them in the phylum Pteridophyta is a heterogeneous assemblage of plants which are quite unlike each other in appearance, as well as unlike the True Ferns. Most familiar of these fern allies are the small-leaved Club Mosses and the leafless green-stemmed Horsetails. Less well known are the tiny Spike Mosses, the rush-like Quillworts, the tropical Psilophytes.

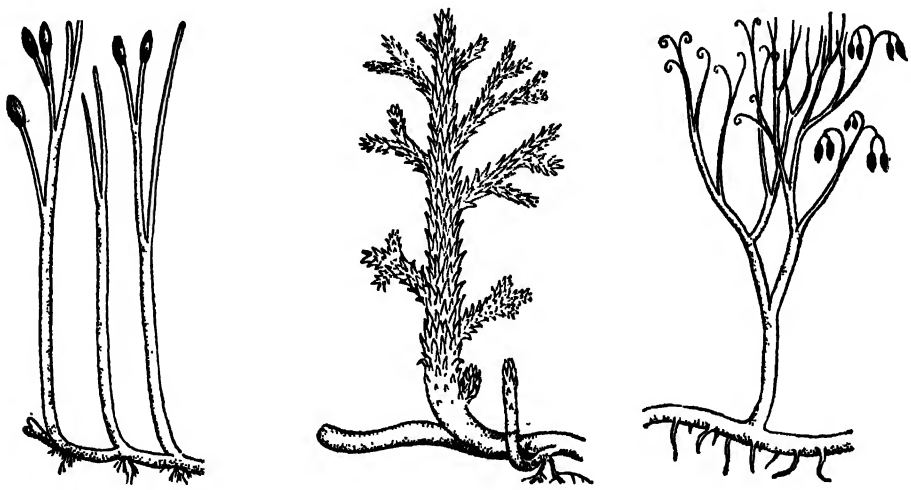
All these are decadent representatives of once powerful and widespread families; they are truly plants with a past. The fossil record tells us little about the soft-bodied plants; what fragmentary record there is indicates plants in these phyla much like the existing species. On the other hand there is an abundant fossil flora of Pteridophytes and Spermatophytes. In the case of the latter, the fossils increase in number and diversity of species as we approach modern times, indicating the small beginnings of the dynasty of the flowering plants which today dominate the land flora. Of the Pteridophytes however the fossils tell a different story. They present a picture of what the first land plants were like, these pioneers in covering the earth with vegetation and thus preparing it for the landward march of the animal kingdom. Fossil plants become very abundant towards the end of this era, when the Pteridophytes were the dominant form of terrestrial plant life, forming the swamp forests which covered most of eastern United States some 150,000,000 years ago. But with the appearance of the Spermatophytes, better fitted in their reproductive habits for land living, the fern plants fought a losing battle for supremacy. The tree-like species died out almost entirely, leaving only the few species of Tree Ferns already described. In their place we find only such survivors of this once mighty race as the herbaceous Club Mosses, Creeping Pines, Horsetails and Scouring Rushes. Today these form an inconspicuous part of the land vegetation, living under water, in swamps, on the borders of streams, in meadows and field. They rarely exceed a few feet in height—a contrast to the forest trees that were their ancestors in the Paleozoic swamp lands. Economically the existing species are of no direct value; the fossil forms, on the other hand, made up the bulk of plant remains that have become converted into coal.

THE FIRST LAND PLANTS

The most ancient of known land plants began their development, as we have already mentioned, in the middle of the Paleozoic Era. These plants belong to the *Psilophy-*

tales, which showed many similarities with the algae, from which botanists assume all land plants (Bryophytes, Pteridophytes and Spermatophytes) have evolved.

The now extinct *Psilophytales* were small plants with forking erect stems growing from a creeping, perhaps underground, rhizome. Most of them were leafless, looking like cylindrical green stems terminated by cone-shaped reproductive organs. Such were the primitive *Rhynia* and *Psilophyton*. Foreshadowing the appearance of a Club Moss was another primitive plant *Asteroxylon* which bore small, scale-like overlapping leaves. These fossils give us a glimpse of what the first land vegetation must have looked like. Here and there in the swampy depressions of the bare earth's crust, where the rocks were mottled with lichen growth and the waters filled with various types of algae, these foot-high fern ancestors raised their green shoots to the sun. It



PSILOPHYTTINEAE

The first land plants—*Rhynia*, *Psilophyton*, *Asteroxylon*.

took millions of years for the descendants of these *Psilophytales* to become widespread forests of giant Horsetails, Club Mosses and Tree Ferns. But in time the *Psilophytales* died out, leaving in their place various descendants better fitted to survive.

A small group of Fern allies living today (the *Psilotales*) are considered a dwindling remnant of these pioneers; they exhibit more primitive characters than any other living Pteridophytes. There are only two genera, both tropical. *Psilotum*, a widely distributed tropical plant, is found in this country only in southern Florida where it forms inconspicuous tufts at the base of Cabbage Palms. The stiff green stems grow by forking, and bear small scale-like leaves. *Tmesipteris*, of the Philippines and New Zealand, has an unbranched stem with more conspicuous, lanceolate leaves.

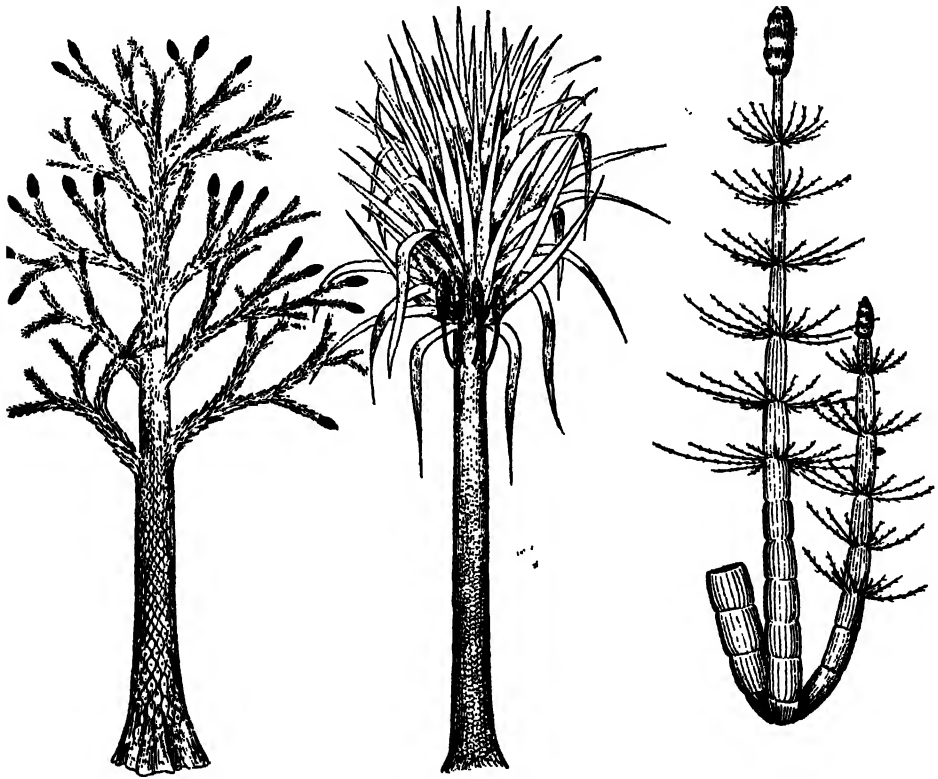
THE CLUB MOSSES AND THEIR RELATIVES

The Club Mosses (*Lycopodiaceae*) are small plants with a trailing or creeping habit due to the horizontal, often underground, main stem from which grow the erect foliage shoots. The small, scale-like leaves overlap and cover the stem completely.



Psilotum is a rather rare Fern Plant, relic of a primitive group which were the first land plants: its forking green stems with small scale-leaves form inconspicuous tufts at the base of Cabbage Palms in Florida. Compare the size of the *Psilotum* with the severed palm leaf petiole at the left.

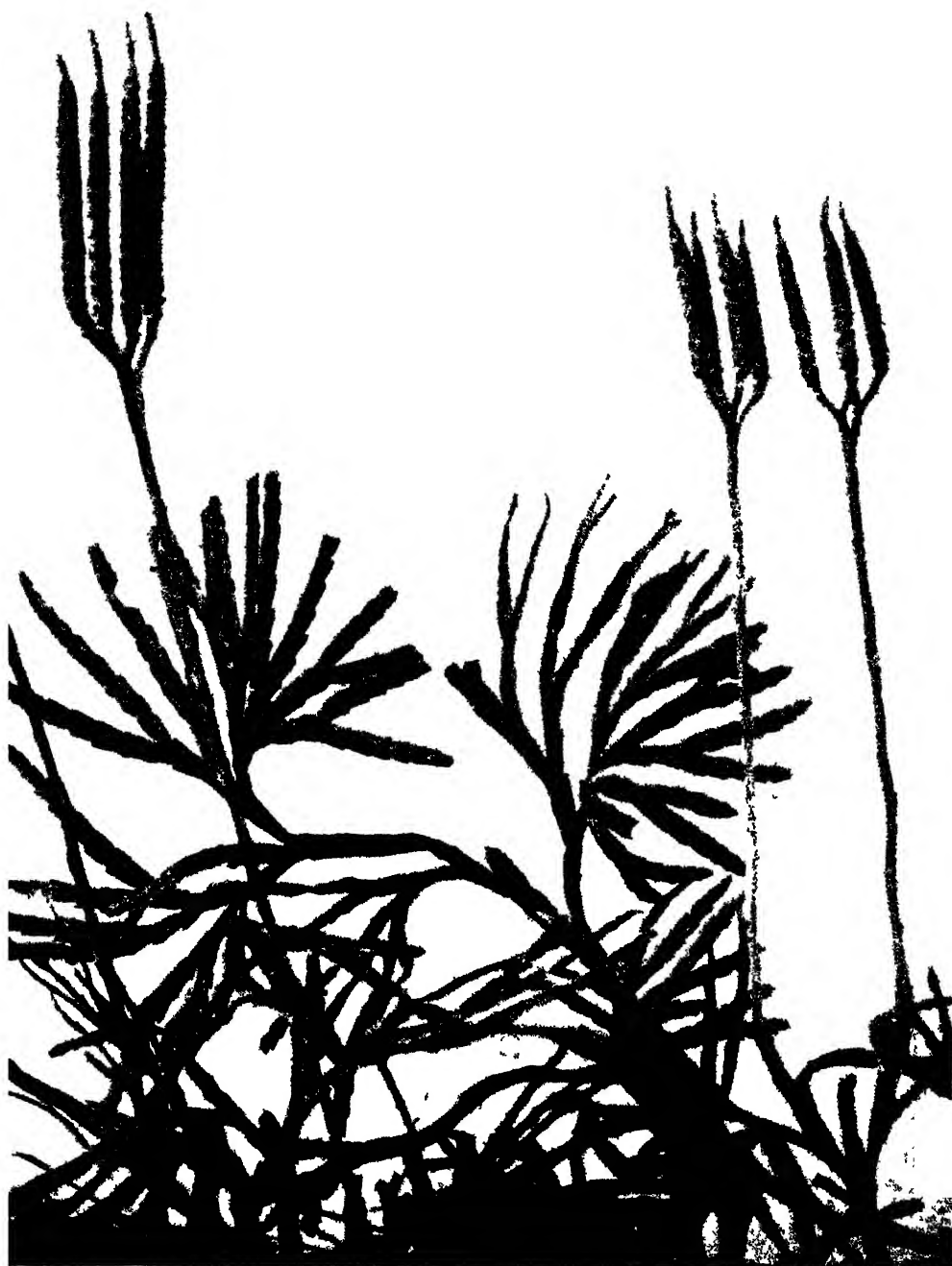
During the reproductive stage, spores are produced in sporangia which may occur either at the base of the leaves, where they join the stem, or in cones at the tips of the erect stems. Of the hundred or more species of Club Moss (*Lycopodium*), most of them are tropical and grow as epiphytes; less than twenty are found in eastern United States. Some of the hardier individuals are evergreen. These are collected—often too recklessly since the plants can easily become rare in an area—for Christmas decorations.



LYCOPODINEAE AND EQUISETINEAE

Tree Club Mosses of the past—*Lepidodendron* and *Sigillaria*; Tree Horsetail *Calamites*.

The Shining Club Moss produces clusters of erect, stiff stems, each completely covered with the dark green, shining leaves. The sporangia are borne at the base of the leaves, these leaves forming distinct zones in between the sterile ones. Most of the other species have the sporangia in clusters at the tip of the stems, where they form conspicuous yellowish brown cones. More tree-like in habit of growth than the other Club Mosses is the Ground Pine; in this plant the erect stem produces bushy side branches, all covered with the small densely-crowded leaves. At the center of the tip of the plant, short leafless stems produce the cone-like reproductive organs. The horizontal stem is often so deep under ground that these erect branches look like separate plants. They also grow in rich damp woods, where they resemble small



Ground Cedar (*Lycopodium flabelliforme*) is a fern relative with overlapping scale-like leaves which resemble those of the Cedars

evergreen trees forming diminutive forests. The Ground Cedar is also somewhat tree-like in habit, though not as tall and erect as the Ground Pine. The flattened branches with their closely overlapping leaves look very much like sprays of Cedar. This species prefers drier locations than the others, often being common in coniferous woods. Running Pine has a more compact, moss-like appearance; the erect stems with their short yellowish-green leaves form more slender growths. The trailing stem, frequently hidden beneath the accumulation of humus and plant debris, may reach a length of ten feet. The erect yellow cones look like delicate candelabra rising from the tangle of foliage leaves and trailing stems.

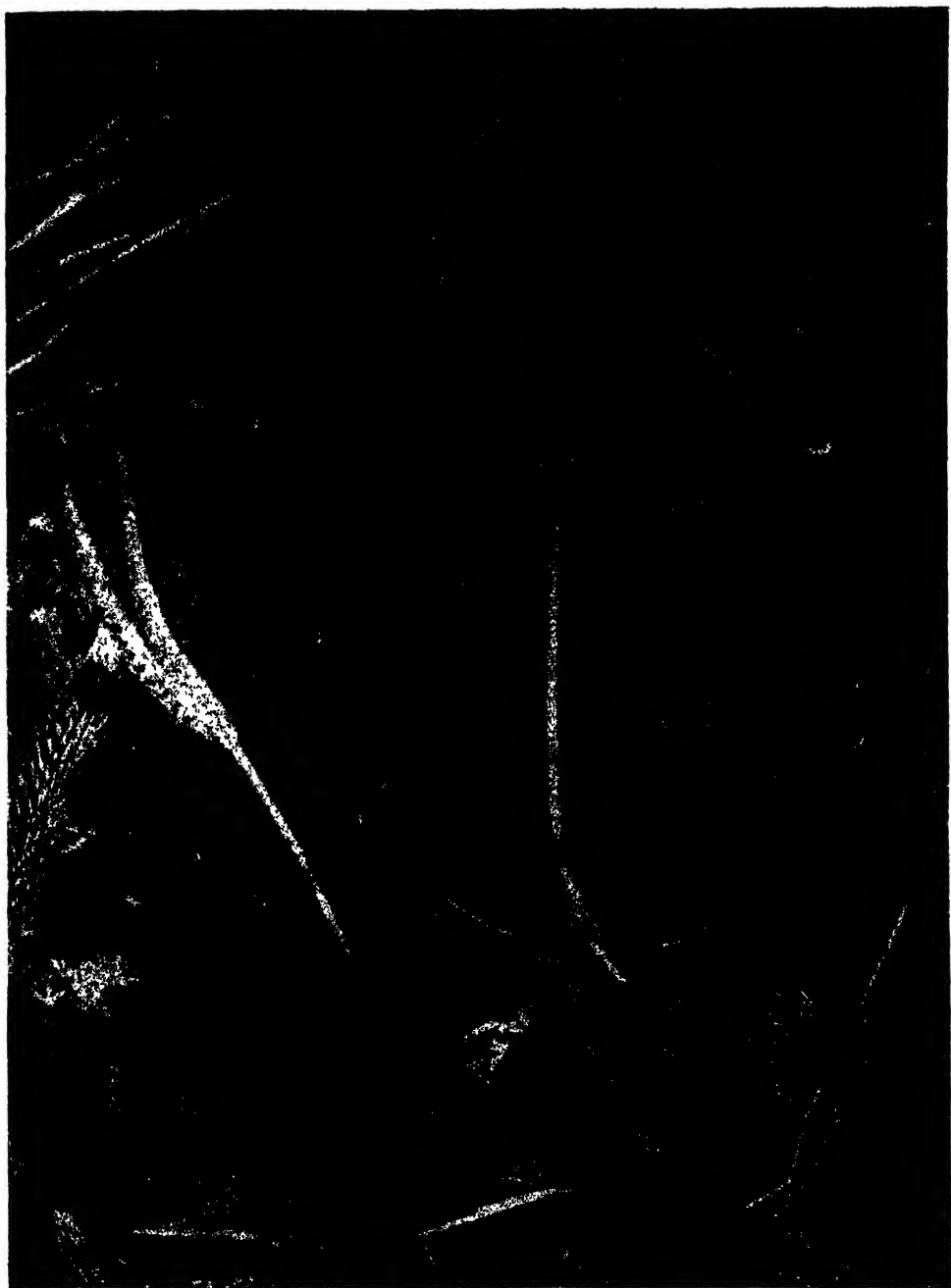
The Spike Mosses (*Selaginellaceae*) are closely related to the Club Mosses. They are small moss-like plants which form delicate growths over ground, trunks of trees, and rocks. In one common species, the leaves appear to be in two rows with smaller leaves on the other side of the stem. The Spike Moss (*Selaginella*) thrives in wet grassy places or on rocky ledges.

The Quillworts (*Isoetaceae*) are little-known relatives of the Club Mosses which spend their lives hidden beneath the surface of ponds and streams. The Quillwort (*Isoetes*) is a rush-like plant, consisting of a rosette of pointed, hollow cylindrical leaves. Some of the plants resemble the bulb-producing Flowering Plants. The sporangia are borne at the base of the leaves. The Quillworts though widely distributed are especially common in glacial lakes and rivers. Some of the species grow under water the entire year, others are amphibious and in a few cases, as in the western species, they can survive dryness over a considerable portion of the year.

The fossil Club Mosses were prominent trees in the Paleozoic swamp lands which stretched from New York west to the Mississippi and south almost to the Gulf of Mexico. One of these trees was *Lepidodendron*, an unusual, sparingly branched tree with clusters of short, pointed leaves covering the terminal portions of the topmost branches. The leafless trunk, several feet in diameter and fifty feet in height, was covered with spiral rows of diamond-shaped leaf-scars, showing where the former leaves had been attached. The sporangia developed in large cones at the ends of the smaller branches. In general appearance, the closest approach to the *Lepidodendron* is the Joshua Tree of southern California. *Sigillaria* was another tree Club Moss of the Paleozoic, mingling with the preceding genus in those primitive forests. As tall as the *Lepidodendrons*, the *Sigillarias* were more sparingly branched and the naked trunks marked with vertical rows of leaf-scars. The leaves were much larger, reaching a length of three feet. Leaves and general habit were much like the living Yuccas. These bizarre trees developed the cones in whorls or rows on the main trunk.

THE HORSETAILS AND THEIR RELATIVES

The Horsetails (*Equisetaceae*) are easily recognized by their jointed stems. They are like the Cacti in being practically leafless, the green stems functioning as food-manufacturing organs for the plants. Each section of the stem fits snugly into the section below it, in the same way that drain pipe sections fit into each other. At the point of union between the two sections is a whorl of small scale-like leaves, lying flat against the stem. These are usually brown or black in color, looking like a circle of teeth. Although some of the Horsetails grow in as moist and wooded locations as do the other Fern allies, many of them have adapted themselves to living in more open and dry



Running Pine (*Lycopodium clavatum*) has a compact moss-like appearance; it bears erect yellow cones which resemble miniature candelabra.



Young Scouring Rushes (*Equisetum laevigatum*) look like pagan towers as they push their leafless and ribbed stems up through the humus; the whorls of small scale-like teeth form rings around the stems



Horsetails (*Equisetum arvense*) produce green sterile plants with whorls of branches, likewise green and taking the place of leaves; and tan colored reproductive plants terminated by the spore-producing cones.

locations. A luxuriant growth of Horsetails can often be found rooted in the cinders and ashes of railroad embankments.

The Scouring Rushes are those species which are perennial; in addition they rarely branch, the plant forming long tapering cane-like growths, three to six feet in height. The Common Scouring Rush (*Equisetum*) has stiff dark-green stems which are ribbed longitudinally. The stems are strengthened by particles of siliceous matter which give them the gritty characteristic that was found valuable in their use as scouring brushes. The Scouring Rushes grow in small thickets along streams and on the borders of swamps. The sporangia are clustered in compact pointed cones at the tips of the leafless stems.

The Common Horsetail (*Equisetum*) is a striking plant with branching stems, some of which are sterile and green, others reproductive and tan-colored. These reproductive stems of the Horsetail are one of the first signs of spring, the tan stems, ringed with whorls of brown scale-leaves, pushing their way upward through the grasses in sunny locations far in advance of the majority of the flowering plants. The stem elongates rapidly, due to growth of each segment, and reaches a height of six to twelve inches; at the tip is a single yellow cone which soon opens its scales to release the clouds of spore dust. When the fertile stems begin withering, the root stock sends up the green sterile shoots which live through the summer. From each joint on the segmented stem there grows a whorl of smaller stems, likewise green and jointed. The succession of whorls of branches, especially when the Horsetail droops earthward, has a fancied resemblance to that animal's tail.

Like the Club Mosses, the Horsetails have an ancient pedigree. In the swamp forests of the Paleozoic, tree Horsetails mingled with the *Lepidodendrons* and *Sigillarias*. Reaching a height of sixty feet, *Calamites* looked like a giant Horsetail identical, except in size, with the living species. The straight trunk was ridged and divided into sections just as in the common Horsetails; and the whorls of branches were similarly ringed with small teeth-like leaves. The sporangia formed cones at the tips of the branches.

COAL FORMATION

One of the most obvious features of our modern civilization is its dependence upon natural sources of energy. In a few countries water power is utilized in wholesale fashion to create electrical energy. But by far the chief sources of energy today lie in the scattered deposits of carbonaceous matter—petroleum and coal. We have already seen that petroleum can be considered fossil sunlight, in that it is the carbon residue of countless minute plant bodies—the diatoms. In their short life span they converted the carbon dioxide of the air into organic substances, thereby storing up the carbon in oxidizable form, using solar energy to carry on the process. Coal is likewise fossil sunshine, in that it is the carbon residue of plant bodies, the carbon material being "fixed" in this energy-yielding substance as a result of utilizing solar energy.

When plants die they become subject to bacterial decomposition, which is a slow release of the carbon and energy. This constant dissipation of energy takes place whenever plant bodies are subject to atmosphere and bacterial action. However, if the plant body is protected from these two agencies, the carbonaceous matter remains locked up in the plant remains. Thus plants which grow in locations where they are

likely to fall under water when they die are protected from ordinary oxidation, and bacterial action takes place to only a limited extent. We have seen how Peat Mosses thus become deposits of fuel value. Swamps are the scene of coal formation, and the swamp plants are the coal-formers. During the period of most extensive swamp conditions in the United States (the late Paleozoic Era) the dominant plants were Pteridophytes. As the giant Horsetails, Club Mosses and other tree Ferns fell beneath the waters, their remains accumulated as organic muck which gradually changed to peat and then, with pressure and age, to bituminous coal and finally to anthracite. Coal deposits are generally rich in fossils, especially of the tree species of Horsetails and Club Mosses.

Thus, even though the Ferns and the Fern allies seem of little economic importance today, their abundance in the past has made possible the storehouses of energy upon which we are dependent for the motive power of civilized progress.



SPERMATOPHYTA: GYMNOSPERMS

The NAKED-SEED PLANTS (*Gymnosperms*) are the most primitive of the familiar plants producing seeds; they are characterized by a reproductive structure known as a cone, which is in reality a primitive kind of flower. The seeds lack the protective coverings which in the highest type of Seed Plant is known as the fruit. Among these Naked-Seed Plants there are fossil remains of many species now extinct; of the living members, there are the Cycads, with fern-like leaves, the Maidenhair

Tree—sole survivor of a once widespread group—and the Conifers. The entire Conifer group—including the familiar Pines, Spruces, Cedars and Sequoias—have established themselves as successful forest trees, constituting the most conspicuous aspect of the vegetation in cool and mountainous portions of the United States.

CHAPTER X

The Most Primitive Seed Plants

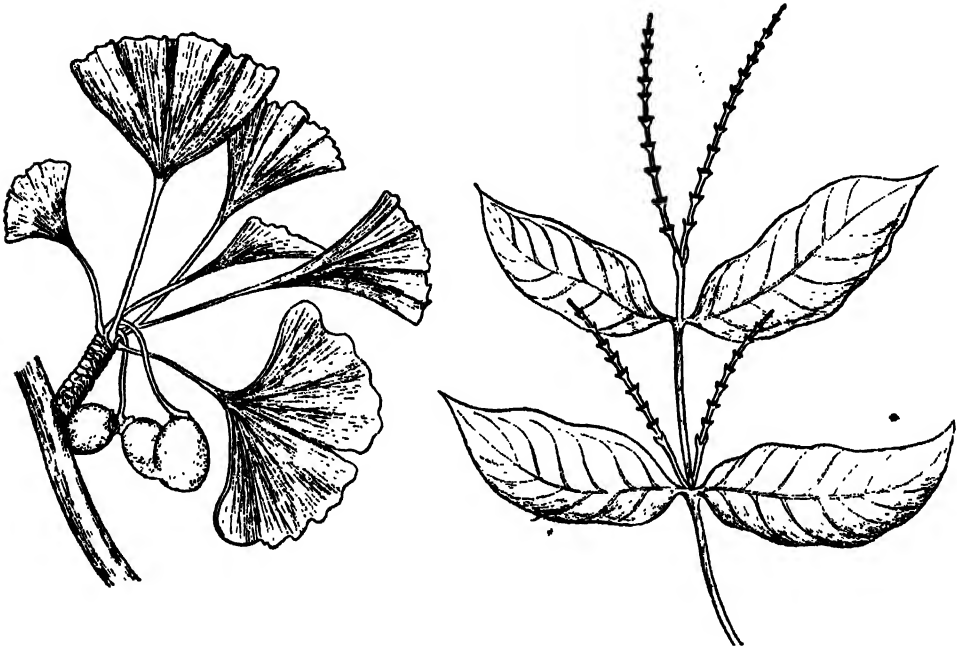


THE most highly evolved phylum of the plant kingdom is characterized by the production of seeds, the seeds being produced in various ways by catkins, cones or flowers. The Seed Plant phylum is known as the *Spermatophyta*. In all the preceding groups of plants, from the Algae and Fungi to the Pteridophytes, the young plant or embryo is left to shift for itself as soon as its identity is distinct from that of its parent; often this is as soon as the egg is fertilized or the spore is mature. These immature plants are left at the mercy of the environment, and millions die before reaching maturity. It is only because of the countless eggs or spores produced, that enough survive by chance to continue the race. There is a parallel condition among the lower vertebrate animals in the chance survival of any one of the thousands of fertilized fish or amphibian eggs, unprotected by special coverings or nutritive tissues. The more care a group of organisms gives to the protection of its immature young, the more likely the group will survive and increase in numbers. This is one reason for the superiority of Mammals over other vertebrates; the egg developing internally and under the special protection and nourishment of the maternal tissues before being released into a world where the new organism must struggle to survive. The *Spermatophyta*, among plants, correspond roughly to the Mammals among animals. The fertilized plant egg is not at once exposed to the vicissitudes of the hostile world, but instead develops into a "baby" plant while still within the parent tissues. The embryo, with the surrounding protective and often nutritive tissues, is known as the seed. True seeds are not found among any of the living plant phyla we have so far considered. Seeds are peculiar reproductive structures typical only of this last, and largest, phylum.

All the Seed Plants are not alike in their method of seed formation. A few—some six hundred species—are more primitive in that the seeds are not enclosed in a fruit. In the spruce or pine, for example, the seeds are produced on scales which grow closely together to form a cone. There is no protective tissue around the seed, in the sense that there is among the majority of the Spermatophytes. This condition of having naked or unprotected seeds is typical of most of the Spermatophytes which are known as *Gymnosperms*. These include the so-called "evergreen trees" or Conifers, the tropical Cycads and a few other interesting but less well-known plants; most

of them are trees or shrubs, producing the seeds in catkins or in cones. In the other, larger group of the Seed Plants, known as the *Angiosperms*, the seeds are produced with few exceptions by flowers with the usual petals and sepals; the seeds themselves being embedded in a fruit which is developed from the ovary of the flower.

In the classification of organisms, the largest unit, already familiar to the reader, is the *phylum*. The phylum is made up of *classes*; in the Pteridophyte phylum the common classes are the Club Mosses (*Lycopodiaceae*), the Horsetails (*Equisetaceae*) and the True Ferns (*Filicineae*). In the phylum Spermatophyta, which is the subject

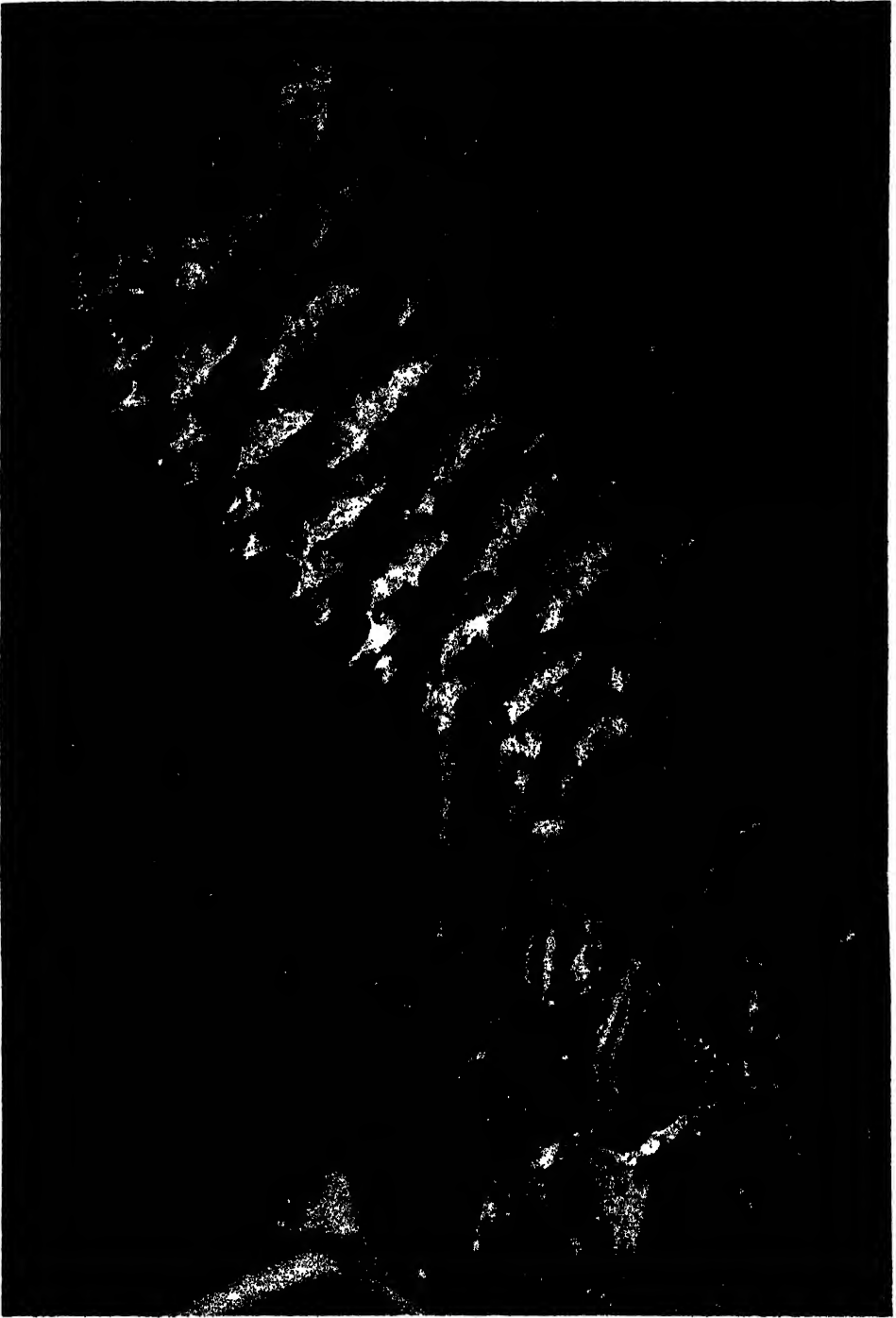


GINKGOACEAE AND GNETAEEAE

Maidenhair Tree. *Gnetum*.

of the remainder of this volume, there are the two well defined classes *Gymnosperms* and *Angiosperms*. However, within the class we find many variations in structure and habit which make it possible to form still smaller groups, known as *orders*. A class may be made up of two orders, or of a hundred, depending upon the divergence of the species which belong to the class.

The *Gymnosperms* are a collection of seven orders, several of them including plants all of which are extinct. These extinct and living orders constitute the more primitive Seed Plants, some of them being distinct connecting links with the Pteridophytes from which many botanists assume the Seed Plants have evolved. The most primitive order, even though it has no living representatives, will be mentioned because of its evolutionary interest; it is known as the Seed Ferns, or *Cycadofilicales*. Closely related to the Seed Ferns is the order of the Cycads, or *Cycadales*. Then there are two apparently unrelated orders, each with only one or a few species living today in widely



The inflorescence of a Cycad (*Ceratophyllum*) is a massive cone-like structure seated in the midst of the crown of leaves. New York Botanical Garden.

the Mesozoic Era, companions to the dinosaurs throughout their reign. Cycads have pithy, unbranched stems which reach a diameter of a foot; the stem is covered with the rough remains of old leaf stalks. At the summit of the stocky trunk—rarely more than a few feet high—is a compact cluster of stiff, dark green leaves which are fern-like in being subdivided into leaflets. Cycads reproduce by having modified leaves form cone-like organs, one type for the production of pollen, the other for the production of ovules.

Of the eighty-seven species living today, only four are found in the United States. These are all species of the Sago Palm (*Zamia*) found on the dry pine barrens, the sand dunes and keys of southern Florida. The plant was known to the Seminoles as the White Bread Plant, since the starchy underground stem was the chief source of their flour. The other Cycads are tropical in distribution, and therefore can be grown outdoors as ornamentals only in such states as Florida, the Gulf States and California. *Cycas* is a common ornamental in these states, though its native home is in Japan and China. Other genera grow in Mexico (*Dioon* and *Ceratosamia*) and in Australia (*Bowenia*, *Macrozamia*).

THE MAIDENHAIR TREE

It often happens that a once numerous group of plants or animals, in the course of evolutionary history, dwindles in numbers and leaves behind but a single living species to remind us of a once flourishing race. Among plants, the best example of such survival is the Maidenhair Tree (*Ginkgo*) which Darwin called "the living fossil". This slender tree, reaching a height of sixty feet, is today found native only in China and Japan, and even there rarely except in cultivation. It has been introduced as an ornamental street tree into many American cities, being found as far north as Massachusetts. But millions of years ago, back in the time of the dinosaurs, Maidenhair Trees and their relatives were abundant in such widely separated areas as Alaska, England and Spitzbergen. They can trace their ancestry directly back to fossils found among the first land plants of the mid Paleozoic.

The Maidenhair Tree has small fan-shaped leaves, each several inches in length and marked with prominent parallel veins; the leaves are similar in shape to those of the Maidenhair Fern, which is the reason for its name. Short catkins produce the pollen, while the ovules are found in pairs at the swollen tips of special stalks. Unlike most of the other Gymnosperms, the seed is embedded in a pulpy fruit-like structure which resembles a cherry.

THE GNETUM PLANTS

There remains one more unusual order of Gymnosperms, the *Gnetals*, which appear unrelated to any other living plants. They undoubtedly are Gymnosperms, since the seeds are not enclosed in fruits; but they have woody and floral characteristics found only among the Angiosperms. There are three plants in the order.

Mormon Tea (*Ephedra*) is a shrubby desert plant common to the arid wastes of the American southwest. Growing with greasewood and cacti, it forms dense green bushes four or five feet high on waste lands from Texas to California. The stiff branching stems are green, while the leaves are reduced to small scales in whorls on the jointed stems. The name *Ephedra* is the ancient Greek term for Horsetail, and is appropriately

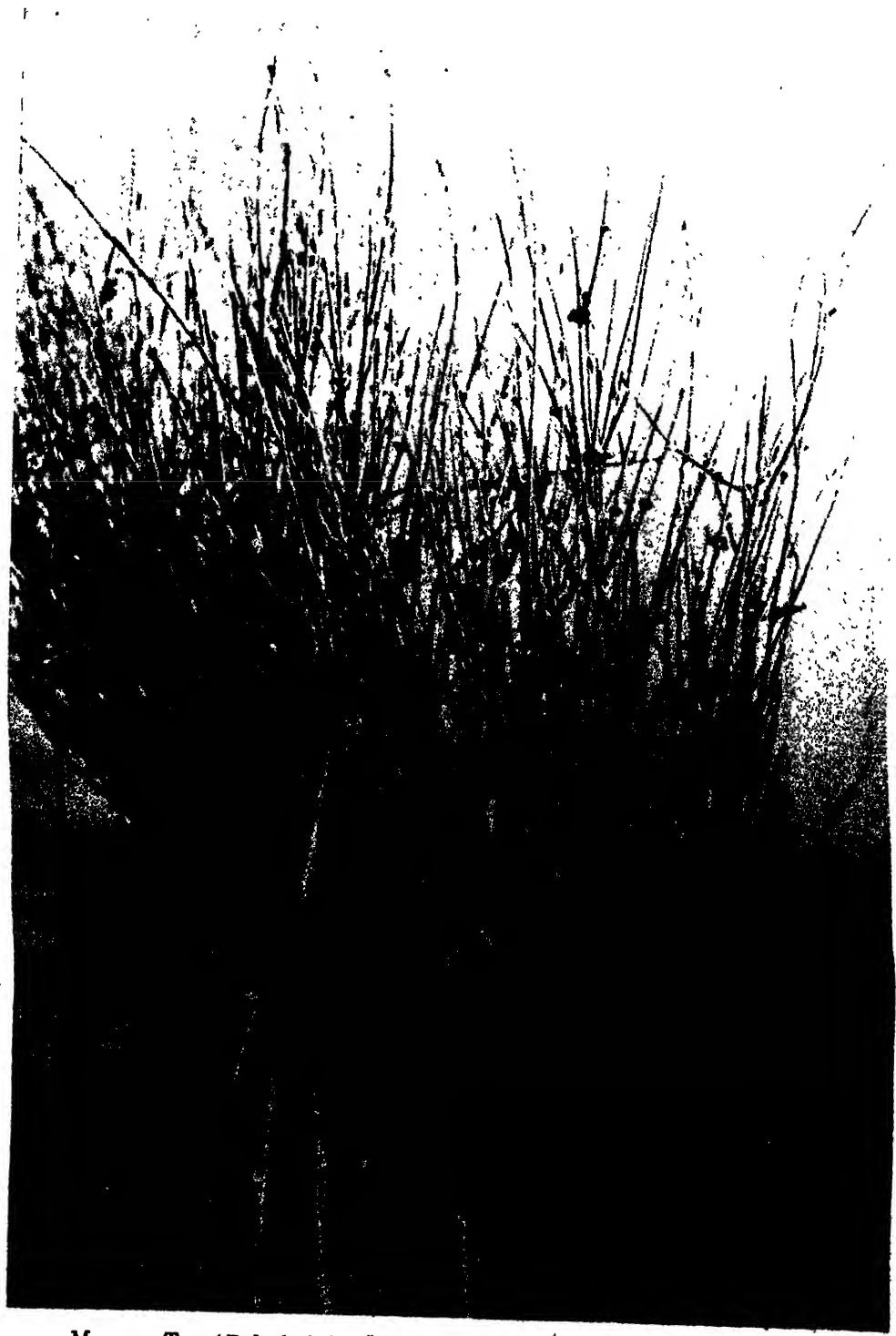


Cycads were once a widespread group of plants, particularly during the reign of the dinosaurs; fossil trunks such as this one in the Yale University Museum are commonly found, showing the former abundance of these primitive Seed Plants.

applied to this leafless plant with jointed stems. The thirty living species are widely distributed in the warmer regions of the earth from southern Europe, northern Africa, Asia and tropical America. The reproductive organs are in the form of small erect cone-like catkins at the joints in the stem.

The other two genera included in the Gnetales are not found in the United States. *Gnetum* is a woody vine which sometimes becomes a small tree, common to the tropics. The netted-veined entire leaves look like those of an ordinary broad-leaved flowering plant. *Welwitschia* is perhaps the most unusual plant of the whole Gymnosperm class. There is but a single species, restricted to the deserts of southwestern Africa. Most of the plant is a large underground tap root, which stores water and food for the slow-growing plant. There is no stem, the crown of the root just above the earth's surface producing two strap-shaped opposite leaves which are the only ones produced by the plant in its entire lifetime. Year after year, the leaves grow at their base, become torn and twisted at the tips as they are exposed to desert storms. In some cases the leaves become shredded into many long thong-like strips. In the center of the crown numerous small cone-like organs on short stalks produce the reproductive cells.

Such were a few of the primitive Seed Plants which ushered in a new era in plant evolution ; in their appearance and habits they hardly gave signs of the great variety of flowering plants which make up the rest of the *Spermatophyta*, or of the Conifers which today are such cosmopolitan relatives of the first Seed Plants.



Mormon Tea (*Ephedra*) is a shrubby desert plant with stiff green leafless stems, only representative of the *Gnetales* in the United States. Photographed near Las Cruces, N. M.

CHAPTER XI

The Cone-Bearing Trees



THE plant life of the land is composed of three general types of vegetation—forests, grasslands, and desert. The type which will predominate in a particular region is determined by the environment ; and the variety of vegetation, with its resulting diversified scenery, is largely due to the fact that different geographical areas present slightly different environmental factors which exclude certain kinds of plants and modify those able to grow there. Two of the most important factors are temperature and rainfall, a combination of the two determining whether a region shall be desert, prairie, or forest.

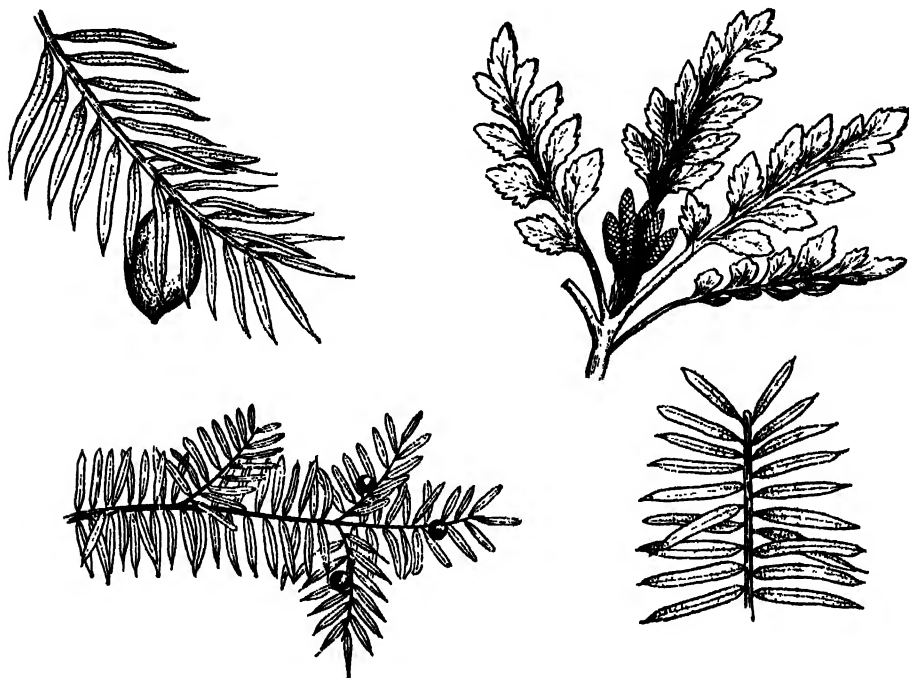
Temperature varies with the distance from the equator and with the altitude ; other conditions being favorable for plant growth, the higher the temperature throughout the year, the more luxuriant will be the vegetation. With high temperatures and abundant rainfall there will be a tropical jungle such as in the Florida hammocks— islands of dense Angiosperm growth in the grassy swamplands. On the other hand, with the same high temperatures and a scanty rainfall, the flora will be limited to fewer species and these in less profusion, as on the Mojave desert of California.

There are regions on all the continents which have a very scanty rainfall. These are the deserts of the world, as are found in southwestern United States, western Australia, Asia and Africa. Here we find a few Gymnosperms, but relatively more highly-specialized Angiosperms such as the Cacti and other succulent plants. Where the rainfall is slightly more abundant, grasses dominate the vegetation. These form the prairies and steppes such as in our mid-west, in Russia and on the Argentine pampas. Here also there are few Gymnosperms. The occasional tree species that do occur are usually Angiosperms.

Tree growth is intimately related with ample rainfall, a warm growing season and a winter without too dry air and high winds. Arctic regions have stunted forests, if any at all, for the latter two reasons as well as because of the low temperatures. In the warmer tropical countries the forests are dominated by woody deciduous Angiosperms ; these trees become giants in girth, if not in stature. They are usually covered with a tangle of epiphytes and massive vines which form an impenetrable jungle. Broad-leaved deciduous forests of Angiosperms are found in some parts of the temperate zone, the best example being the region between the Mississippi River and the Atlantic coastal plain. But in the cooler temperate regions the most conspicuous mem-

bers of the forests are the Conifers. These woody members of the Gymnosperm class are at their best on mountain slopes and highlands where the rigors of winter prevent Angiosperm tree growth; they also are able to grow on sandy, rocky or otherwise poor soil. They also flourish on the southeastern coastal plain.

Our common Conifers have small scale-like or needle-like leaves which are fitted by nature to prevent escape of water from the plant. Thus these trees can retain their leaves in winter, a habit which gives them the common name of "evergreen" trees. Angiosperm trees, in the same climate, adapt themselves by shedding all their leaves



TAXACEAE

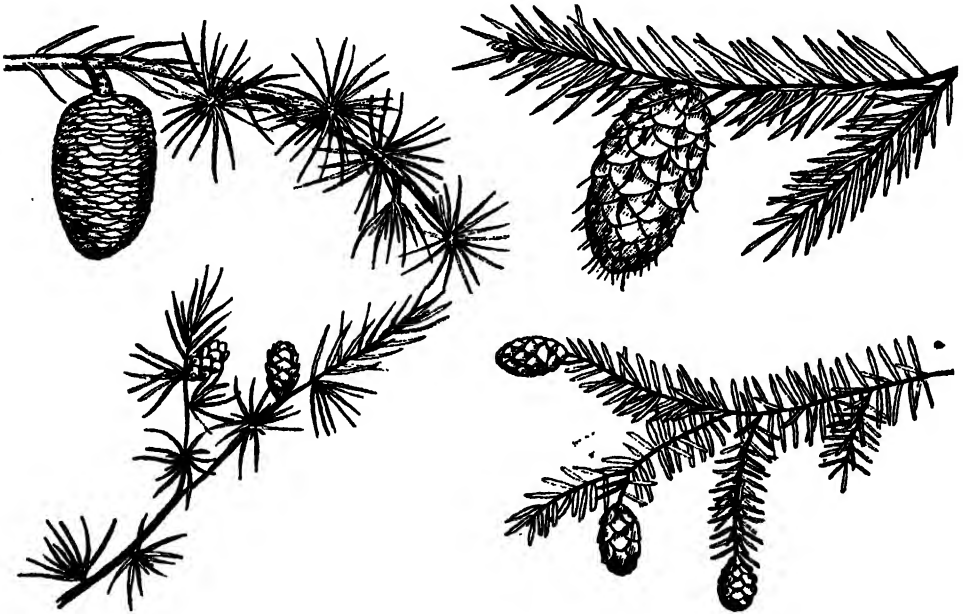
California Nutmeg (upper left), *Phyllocladus* (upper right), *English Yew* (lower left), *Plum Yew* (lower right).

and remaining bare-limbed during the cold season. Broadly speaking, most of the evergreen trees are Gymnosperms—the most noticeable exception being the Live Oaks; and most of the deciduous trees are Angiosperms—the notable exceptions being the Larches and Bald Cypress.

Some of the forests of the north temperate zone are made up of magnificent stands of Conifers. In northeastern United States there are forests of pine, fir, hemlock and spruce. South of this, along the coastal plain from Virginia to the Gulf of Mexico, is a narrow forest belt of pine and Bald Cypress. West of the prairies in the Rocky Mountain region is another expanse of forest dominated by pine, spruce and Douglas Fir. Still farther westward on the rain-drenched slopes of the Pacific coast ranges are the majestic groves of the largest trees in the world—Sequoias, pines, cedars and spruces.

Today there are in the United States about five hundred million acres of forest. The trees which make up this vast kingdom of plant life, in the order of their abundance, are the Douglas Fir, Yellow Pine, Redwood, Cedar, Hemlock, White Pine and Spruce—all Conifers. Coniferous forests are the major resource of our continent because of their value in furnishing building materials, pulp wood, naval stores, and many other lesser known products.

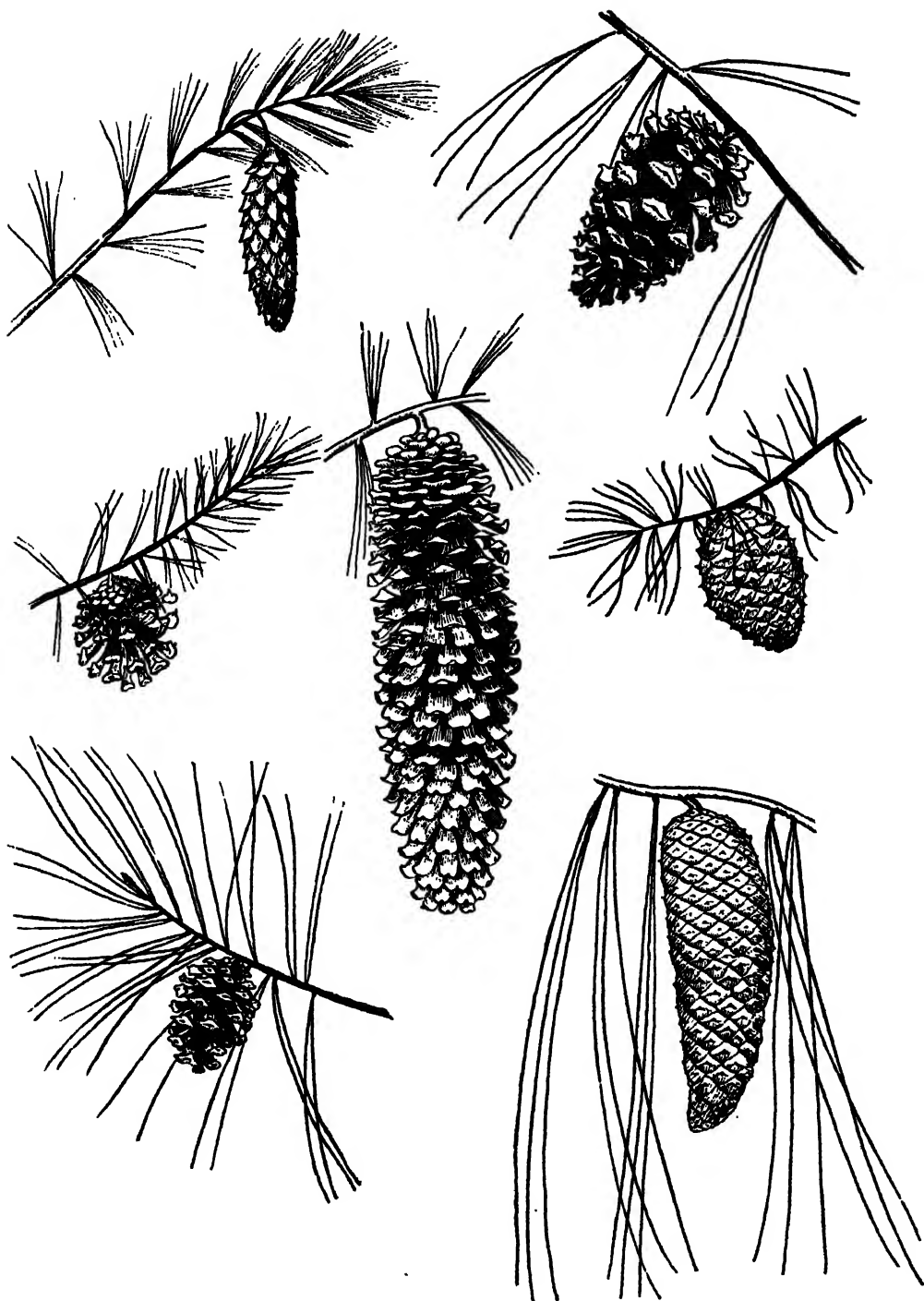
The Conifers (*Coniferales*) include a little less than five hundred species, distributed among various families, of which the following will be treated in this chapter:



PINACEAE

Cedar of Lebanon (*upper left*), Douglas Fir (*upper right*), Larch (*lower left*) and Eastern Hemlock (*lower right*).

(1) The Yew Family (*Taxaceae*), characterized by a fleshy berry-like or nut-like covering to the seeds instead of the usual cone, includes the Yew, the California Nutmeg, the Florida Cedar, and various introduced Oriental and Australian evergreens used as ornamentals in southern United States. (2) The Pine Family (*Pinaceae*) is the largest family of the Conifers, characterized by linear or awl-shaped leaves and seeds attached to scales of woody cones. In this family are the pines, spruces, firs, hemlocks, true cedars and larches. (3) The Redwood Family (*Taxodiaceae*) also has linear or awl-shaped leaves, but the cones are usually more globular and smaller than those of the Pine Family. There are two American genera, the Swamp Cypress and the Sequoia (Redwood and Big Tree). (4) The Cypress Family (*Cupressaceae*) can generally be recognized by the small scale-like overlapping leaves; the reproductive structure may be either a small cone or a berry-like fruit. This includes the Arbor Vitae, cedars, junipers and the true cypresses. (5) The Araucaria Family (*Araucari-*



PINACEAE

Upper Row: White Pine and Western Yellow Pine.

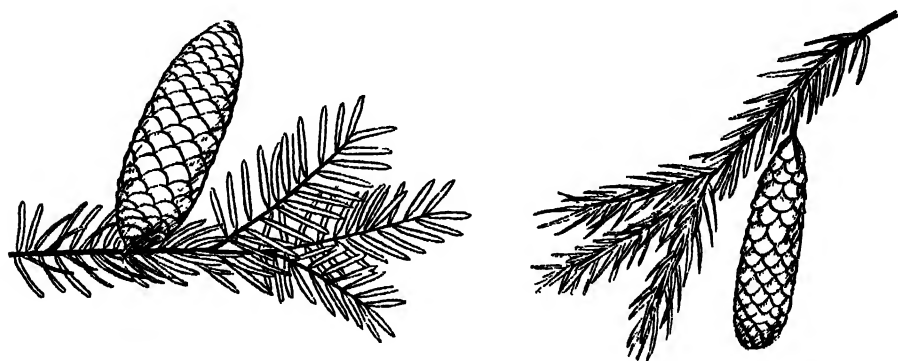
Middle Row: Lodgepole and Pitch Pine.

Center: Sugar Pine. Lower Row: Red Pine and Longleaf Pine.

arauc) is not native to North America, but some of the species of *Araucaria* are common ornamentals of Florida, along the Gulf of Mexico, and in California

THE YEW FAMILY

The Yews (*Taxus*) are slow-growing evergreen shrubs or small trees with flattened linear leaves, arranged on two sides of the stem thus giving a flattened appearance to the spray. The leaves, averaging an inch in length, are a dark glossy green on the upper surface, a more yellow green on the under side. The bright scarlet "berries" are unusual for Conifers. The strong and elastic wood made this the chief material for bows, in fact, the word "taxus" is the classical word for bow. The Common Yew of eastern United States is a low bush, while the Pacific Yew, found in the canyons of



PINACEAE

Balsam Fir and White Spruce

the California mountains, grows to be a small tree. English and Japanese Yews are often introduced as ornamental evergreens.

Closely related to the Yew is the *Torreya* tree, named for the distinguished American botanist, John Torrey. This evergreen tree has glossy dark green foliage of flattened needles much like those of the Yew. The nut-like covering to the seed is surrounded by a green or purple fleshy skin. Its distribution is most unusual, the existing species being found widely separated, in China, Japan, California and Florida. The Florida species is known as Stinking Cedar because of the odor of the bruised foliage, it is restricted to a small area on the bluffs of the Appalachicola River, near Tallahassee, Florida. To protect this rare species, found nowhere else, the area has been made the Torreya State Park. The California species is known as the California Nutmeg, it too is found only in a restricted range, in the vicinity of the Santa Cruz Mountains of California.

There are various related Conifers from the south temperate zone. The Plum Yews (*Cephalotaxus*) from China and Japan are small bush-like trees with flattened needles and nut-like fruits surrounded by a thin fleshy envelope. The Heron Pine (*Podocarpus*), common to the New Zealand bush, and to Africa and China as well, has been introduced into southwestern United States. *Phyllocladus* is an interesting



A mixed stand of coniferous (Spruce) and deciduous trees in the Adirondacks, New York.

New Zealand member of the family with leaves reduced to scales and the twigs enlarged to form flattened green leaf-like structures, known to botanists as cladodes.

THE PINE FAMILY

This family is easily recognized by the needle-like leaves and—in most species—the woody cones. Those with short linear leaves might be confused with some of the Yew or Redwood Families, but the fleshy fruit-like cone of the former and the restricted distribution of the latter, make identification relatively easy. Three members of the family have the needles in clusters—the pines, larches and true cedars. The other



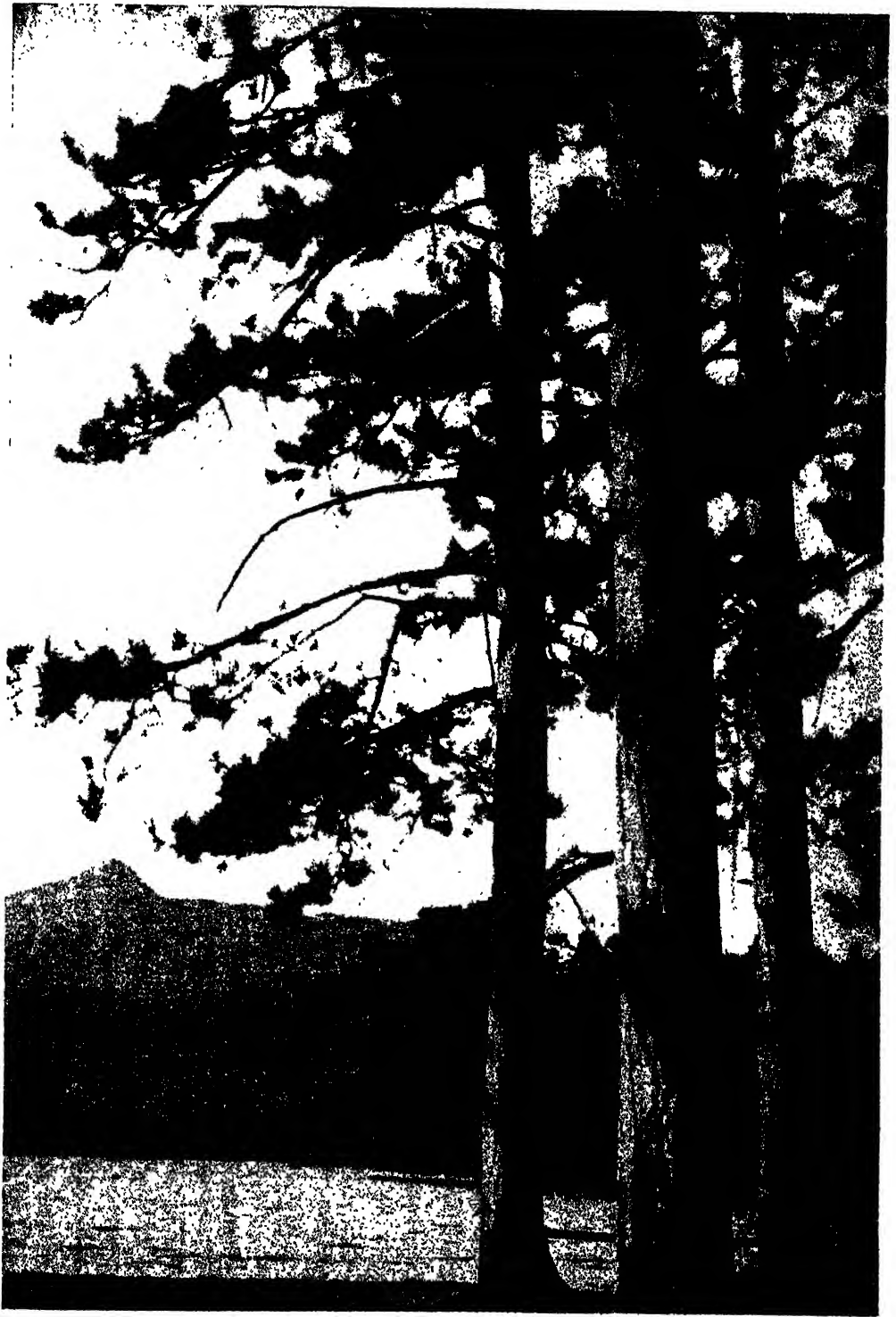
TAXODIACEAE

Upper Row: Big Tree, Coast Redwood.

Lower Row: Bald Cypress and *Cryptomeria*.

four have the leaves scattered singly along the twigs—the spruces, firs, Douglas Fir, and hemlocks.

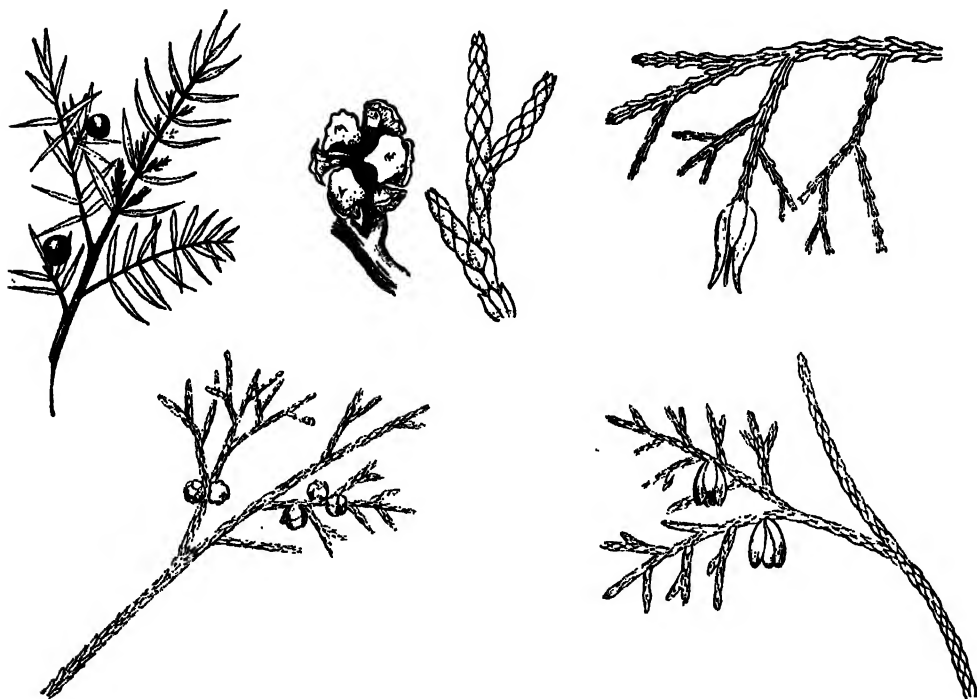
The Larches (*Larix*) are deciduous Conifers, losing their needles in winter; they are common in the colder portions of the north temperate zone. The Eastern Larch, or Tamarack, is a tall pyramidal tree with the awl-shaped needles in rosettes of a dozen or more. This tree is particularly attractive in spring, with its light green, feathery foliage; in autumn the needles turn yellow and drop off much as do the leaves of deciduous trees with broad leaves. The Tamarack is a hardy individual, living farther to the north (Labrador) than any other Conifer. Southward it thins out to form pure stands in cold swamps where few other trees prefer to live. The hard



The majesty of Pines (*Pinus*) at Lake Chocorhua, New Hampshire.

wood is heavy and strong,—ideal for posts, poles and railway ties. The Western Larch, abundant on the slopes of the mountains, is a tree frequently two hundred feet in height. Its bark is used for tanning and the wood for interior finish. The Alpine Larch is a smaller western species also found on the mountains. The European Larch, commonly used as a street and lawn tree, has been introduced from the mountainous regions of Europe.

Many of the Conifers are called cedars, but the True Cedars (*Cedrus*) are the only ones so justified by their botanical characters. They are large evergreen trees, chiefly of the Mediterranean countries, with linear leaves an inch or two in length,



CUPRESSACEAE

Upper Row: Juniper, Monterey Cypress and Incense Cedar.

Lower Row: Coast White Cedar, Arbor Vitae.

spirally arranged on some branches, clustered at the tips of shorter side branches. The Cedar of Lebanon is a massive, profusely branched tree quite unlike most of the evergreens in habit. The Deodar Cedar, a taller and more graceful tree, is frequently planted as an ornamental tree in the southwest.

To the fireside naturalist every Conifer is a "pine"; and it would be a lengthy list indeed if we were to record all the farmhouses, roadside inns and tea rooms which, snuggling under a row of sombre spruces or backed by stately cedars, are named "Twin Pines", "Pine Rest", or just simply "The Pines"! The Pines (*Pinus*) have needles much longer than those of any other Conifer, and these grow in clusters, the number usually being two, three or five. The cones are the largest found in the Conifers, those of some western pines attaining a length of eighteen to twenty inches. All



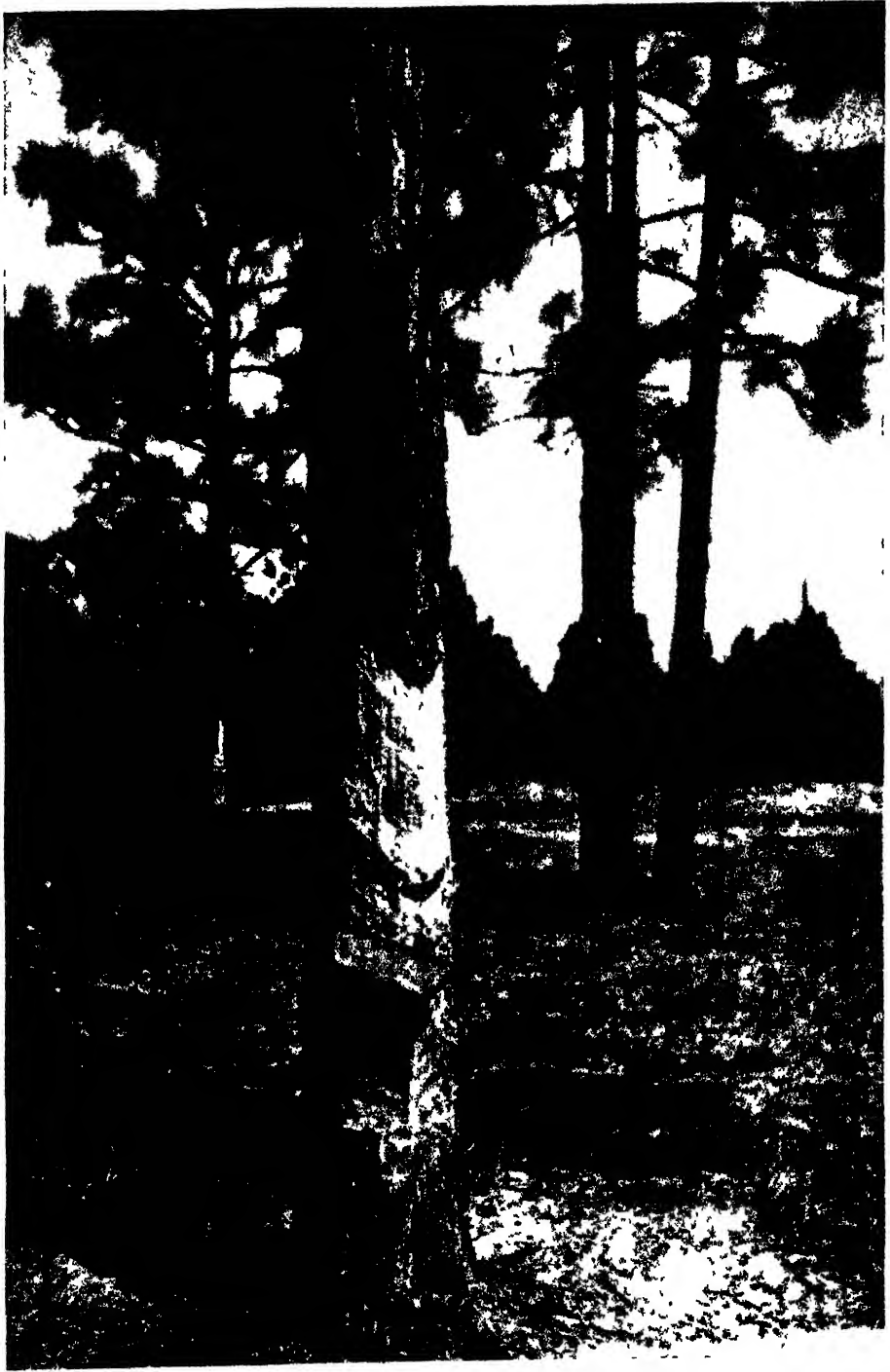
The Slash Pine (*Pinus caribaea*) forms extensive open forests in the Florida swamplands

the pines are inhabitants of the northern hemisphere where there are some ninety species, a third of which can be found native to North America. Few other plants have species with such distinct personalities. Most aristocratic of all is the Eastern White Pine with its well-groomed glossy foliage and stately branching. Rough and sturdy giant of the genus is the Sugar Pine of the west ; a contrast to the dwarfed and stunted southwestern Piñon Pine, the desert rat of the group. Tattered and unkempt, with an Oriental grace in its scraggly, twisted branches and stunted trunk, the Pitch Pine thrives on rocky ledges and among sand dunes. Pines can thrive on soil and in situations which daunt the Angiosperm trees, thus they often form extensive forests on sand plains and rocky mountain slopes.

The Five-needled Pines. The Eastern White Pine usually occurs in groves among deciduous trees. Its pliant needles are lustrous blue-green, and the tall straight trunk often is six feet in diameter and several hundred feet tall. It was the choice tree for use as masts of vessels when New England was the center of the ship-building industry. The straight-grained light wood is soft and easily worked, making it one of the most valuable of our soft woods. Pine is used for hundreds of articles of woodenware, as well as for interior finish and general building purposes. The Sugar Pine of the Cascade and Sierra Mountains equals in size the biggest of the eastern trees, often being over two hundred feet in height with a base diameter of twelve feet. The needles of this pine are stout and rigid, two to four inches in length ; and the cylindrical cones are often twenty inches or longer. The wood is used for interior finish, shingles and general woodwork. Other western five-needled pines include the Whitebark Pine, a characteristic low-growing timber line tree ; the Limber Pine, another low-growing pine of the desert mountain slopes ; the Foxtail Pine ; the Hickory Pine, and the Western White Pine, a tall tree found on the higher mountains of all the Pacific coast states. Their wood is at times used for lumber, and the large sweet seeds are still used by the Indians as a food.

The Nut Pines. These pines have a variable number of needles. The Nut Pine or Piñon Pine of southern California usually has only one needle in a cluster. It is a small tree of dry sun-baked mesas and the arid mountain slopes, its needles colored pale-green like the rest of the desert foliage. This desert pine has an irregular low crown, and is sturdy as a tree must be to live in such regions. The Arizona Pine has darker green and more slender needles in clusters of two or three ; it too is a dwarfed and bushy tree. The common Two-leaved Piñon of the Rocky Mountains is more widely distributed than the other Nut Pines, being found from Wyoming and Utah to Texas and Mexico. The wood, though brittle and weak, is sometimes used for lumber, fuel and fencing material ; its seeds are a food for the Indians and Mexicans.

The Three-needled Pines. The Pitch Pines, as these are also called, have a heavier and coarser grained wood than that of the White Pines. The common eastern Pitch Pine is an unkempt tree of sand plains and poor soil, from eastern Canada to Georgia. The contorted branches, tufted with coarse yellow-green needles, give the tree an exotic appearance which is often very picturesque, redeeming its generally useless character. The Western Yellow, or Ponderosa, Pine is a valuable forest tree which reaches a height of several hundred feet and forms some of the most extensive pine forests of the continent. It is common on the mountain slopes and high mesas from Nebraska

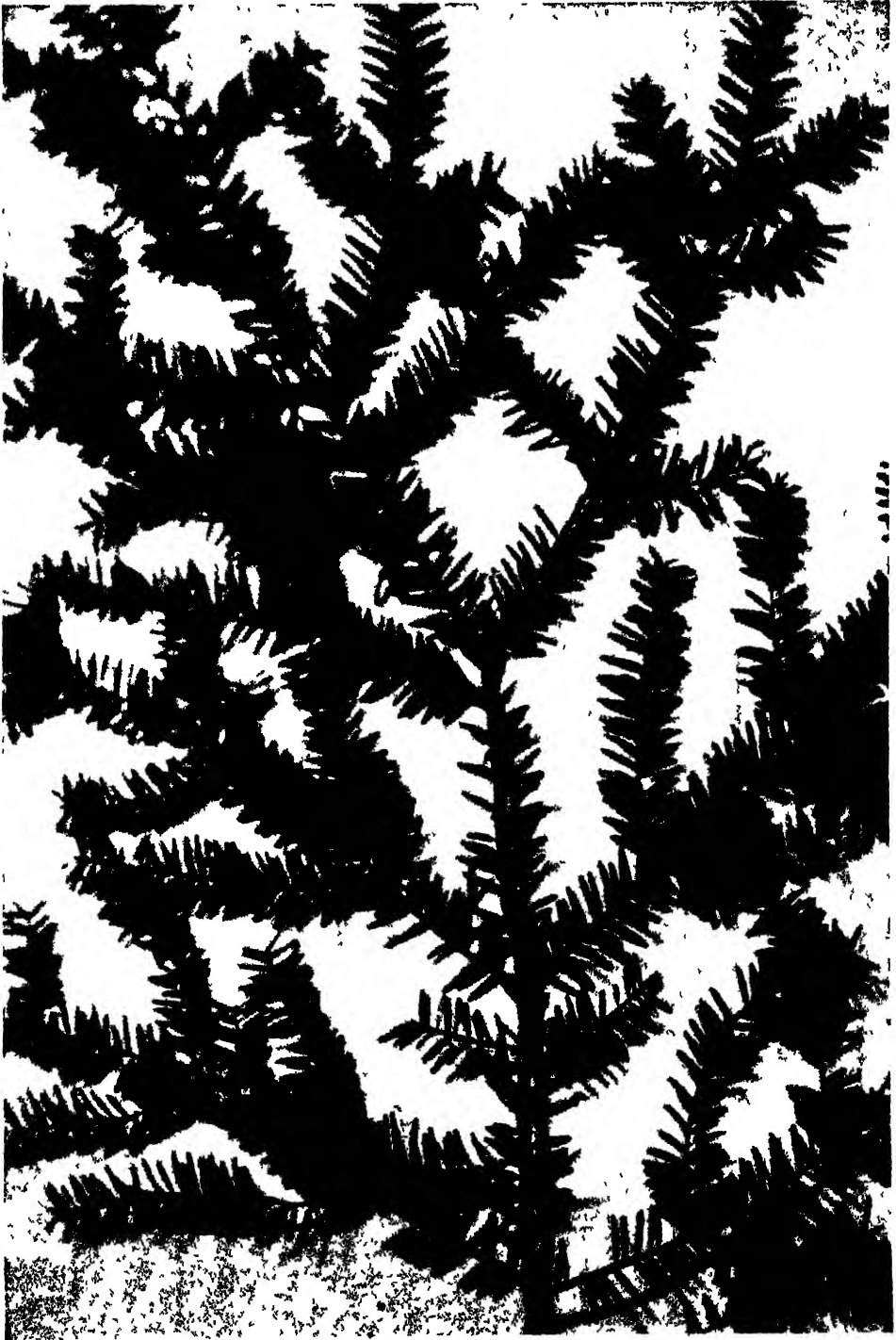


Long Leaf Pine (*Pinus palustris*) of Florida being tapped for turpentine,
near Tallahassee.

and Texas westward to the Pacific coast, where it is the most common tree at elevations up to seven thousand feet. The hard strong wood is becoming increasingly important for general construction. The Long Leaf Pine of the southeastern states has the longest needles of any Conifer, the crowded clusters forming twelve- to fourteen-inch-long tufts. The trees themselves are tall and straight, sparingly branched; they form open park-like groves on the coastal plain from Virginia southwards. The wood is very hard and strong as well as durable; it is important as a flooring and interior finish wood; for use as posts, poles and railway ties. The resinous secretions of this pine produce the valuable turpentine and pitch products which are one of the chief industries of the southeast. The pines are tapped by V-shaped cuts near their bases and the resinous material which oozes slowly out is collected and distilled to yield turpentine, rosin, various oils and tar products, and pyroligneous acid. Ninety percent of our naval stores come from this tree, the industry first centering in the Carolinas and Georgia, now being the most important activity of northern Florida with the depletion of the Yellow Pine forests in the other states. There is also the Slash Pine, which forms miles of open forest on the southern coastal plain and is the common tree in the grassy flatwoods surrounding the Florida hammocks. It is an attractive and stately evergreen tree, whose wood is suitable for heavy construction and from which some turpentine is also secured. The western three-needled pines include the Digger Pine of the foothills and mountains of California; the Bigcone Pine with its stiff needles which are often ten inches long, found in southern California; and the Knobcone Pine of all the Pacific coast ranges.

The Two-needled Pines. The Red, or Norway Pine, is a stately tree with long flexible and dark-green needles; it is found scattered through the woods from Nova Scotia to Pennsylvania. Conspicuous are the broad flat ridges of the bark, covered with cinnamon-red flaky scales. The wood, light and close grained, is used in bridge and boat construction. The Jack Pine, another two-needled pine, is a scrubby little tree with very short and stout needles, found on poor soil from eastern Canada to New England and Michigan. The Eastern Yellow Pine has clusters of dark blue-green needles; it is a tall evergreen ranging from southern New York south and west to Florida and Texas, but reaching its greatest size west of the Mississippi River. The western two-needled species are found in various states. The Shore Pine is a small tree with short, twisted clusters of needles, native to all the Pacific coast states. The Lodgepole Pine is a tall and slender tree of the mountains, extending from five thousand to eleven thousand feet in altitude. Two introduced two-needled pines are the Scotch Pine, of Europe and northwestern Asia, with rigid and twisted blue-green needles; and the Austrian Pine, of southern Europe and western Asia, with longer needles than the Scotch Pine.

The Hemlock (*Tsuga*) has a scientific name which, unlike that of most plants, is not of Greek or Latin origin; but the common vernacular name in Japan. Various species are found in North America, China, Japan, and the Himalayan region. The leaves are short flattened needles which grow in two opposite rows on the stem, and are usually an inch or less in length. The Eastern Hemlock is scattered among deciduous trees, often on the slopes of shady ravines. Its feathery foliage is the most delicate of the Conifers, and the rather open branching and pendulous twigs contribute an airi-



Foliage of a Hemlock (*Tsuga*), showing the small flattened needles borne singly along the stem

ness to this evergreen tree not found in most of the other genera. This tree has long been of importance as the source of the tannins used in tanning leather. Tannins are plant substances which have the property of forming insoluble compounds when added to certain proteins, as when animal skins are converted into leather. Tanning was an early industry in the United States, fifty-one tanneries existing in New England as early as 1650. Oak bark was first used, but the abundance of Hemlock, coupled with its satisfactory tanning qualities, has made it a most important source of tannins since pre-Revolutionary days. At present, over six hundred thousand cords of hemlock bark are used annually in tanning. After the bark is stripped from the trees, the trees can be used for low grade lumber and pulpwood. Hemlock wood is brittle and coarsely grained, being therefore suitable only for making boxes, crates and similar products. The Western Hemlock is a large tree, forming forests up to altitudes of six thousand feet in the Pacific coast states. The light, yet hard and tough, wood makes this a valuable source of wood for rough construction work; its bark is also used for the tannin content. The Alaskan Indians have been known to use the tender inner bark as a food.

The Firs are tall, straight-growing trees with a symmetrical pyramidal shape. The flattened needles, much like those of the Hemlock but larger, are deep green above and a silvery green on the under side, arranged in two rows on the twigs. The seed-forming cones grow erect on the branches, varying in size from two to six inches. The Firs include about forty species, widely scattered through North America, Europe, Mexico and Asia. In all the species the wood is perishable and soft; its chief value is in furnishing a cheap and abundant source of woodpulp for paper making. Within the last decade it has attained importance as one of the best trees for Christmas use, millions being grown expressly for that purpose and harvested annually in the New England states. The Eastern Balsam Fir shows a preference for low swampy ground, but will grow mixed with other evergreens on hillsides and mountain slopes. It is a beautifully symmetrical tree, especially when young. Other species include the She Balsam of the mountains of Virginia, North Carolina and Tennessee; the Giant Fir, the Cascade Fir, the Red Fir and the Noble Fir of the mountains of the Pacific coast states. Many ornamental species have been introduced from their native homes in Greece, Spain, Japan and Algeria.

The ancient Latin name for pitch was "pix"; from this pitchy character of the spruces comes their scientific name *Picea*. The spruces are tall and pyramidal trees, with closely packed whorls of branches circling the main trunk to form a symmetrical mass of foliage. The needles, usually about an inch in length, are four-angled instead of flattened, and grow out from the twigs on all sides resulting in a bristly foliage branch. Some forty species inhabit the colder and more mountainous portions of the northern hemisphere in China, Japan, the Himalayas, Europe and North America. Eight are found in the United States. The wood is too light and soft for general construction purposes, though it is often used locally in this way. Shingles are sometimes made of spruce; boxes and crates commonly so. The resinous sap exuding from the bark is chewed as spruce-gum and has medicinal properties as well. Of recent years the Christmas tree demand has made the cutting and growing of spruces a profitable industry; the spruce shares with the fir the honors as a Yuletide decoration, especially in the East. The most important use of spruce, however, is for paper, since the woody



Red Spruce (*Picea rubra*), showing the typical Conifer habit of growth.
South Brooksville, Maine

fibers pulp readily. There are three eastern species: the Black Spruce, found in cold bogs and wet lowlands throughout northeastern United States; the Red Spruce, forming extensive forests on uplands throughout the same area and familiar to the mountain climber of the Adirondacks and the White Mountains as the pioneer in populating the upper slopes above the zone of deciduous trees; and the White Spruce, an attractive tree with silvery blue-green foliage found along the seacoast of the northeastern United States. The western spruces are more frequently found in extensive forests. The Engelmann Spruce is a tall tree which forms dense woods on the mountain slopes from western Canada south to New Mexico and Arizona, living at altitudes from five thousand to eleven thousand feet. The Colorado Blue Spruce is familiar throughout the United States as a park and garden ornamental; its native home is in the mountains of Colorado and Wyoming. The Sitka Spruce is another of the northwestern species, found in moist and swampy soil. One of the commonest introduced spruces is the Norway Spruce, an importation from northern Europe. The bunches of dark green needles hang downwards from the drooping limbs, giving the tree a rather sombre appearance.

The Douglas Fir (sometimes also called Douglas Spruce) belongs to a separate genus (*Pseudotsuga*). It is a splendid and valuable western tree, reaching its maximum development along the seacoast of Oregon and Washington. The wood is used for general lumber purposes, for railway ties and for fuel. •

THE REDWOOD FAMILY

The Redwood Family (*Taxodiaceae*) includes only eight genera of evergreens, and most of these are found only in Japan, China, Tasmania and other distant lands; the two native American trees are the Sequoias and the Bald Cypress.

Most magnificent of all the Conifers, the Redwoods and Big Trees (*Sequoia*) are today found only in a restricted region on our Pacific coast. In the geologic past, however, they were widely distributed over the Northern Hemisphere. Many different species have been found fossilized in Europe and Asia. In the United States fossil redwood cones have been discovered as far east as New Jersey. The trees which make up the Petrified Forest of Arizona are considered by some botanists to have been Sequoias. Thus the scattered groves of California and southern Oregon are in reality the remnants of a once mighty and widespread race. There are two living species, the Redwood and the Big Tree; the former lives at lower altitudes in the western coast ranges, extending in discontinuous groves from Santa Cruz northward to Oregon, and the latter at higher altitudes in the Sierras. After this largest of all trees was discovered in 1791, considerable discussion ensued as to a fitting name for the genus. The name *Sequoia* was finally chosen, since Sequoyah was a Cherokee chieftain famed for being the originator of the only Indian alphabet.

The Redwood is among the tallest of trees. Many specimens exceed three hundred feet; one tree in the Bull Creek Flat grove of northern California claims the record height of three hundred and sixty feet. In trunk diameter Redwoods are smaller than the Big Trees; though even they are no slim giants with a base diameter of twenty to twenty-five feet. The foliage is quite like that of the Yews or Firs—flattened needles about an inch long forming a two-ranked foliage spray. The cones are surprisingly small, usually under an inch in length. The reddish-brown trunks



Reproductive structures of a Norway Spruce (*Picea excelsa*); staminate cones above, pistillate and seed-forming cone below.



Redwoods (*Sequoia sempervirens*) grow in dense stands at moderate altitudes near the coast of California and Oregon. California State Redwood Park near Santa Cruz.



The Big Trees (*Sequoia gigantea*) are less extensive in their occurrence than the Redwoods; they grow in a few scattered groves high in the Sierras. Sequoia National Park, California.

often extend a hundred feet or more above the ground before the first branches appear. There is an impression of graceful massiveness, of airy charm combined with excessive size, as the straight trunks soar upwards like pillars in a cathedral. Only occasional shafts of sunlight penetrate to the Redwood forest floor, ruddy with a thick deposit of old needles. Redwoods grow no farther inland than the limit of the ocean fog which is necessary for their tremendous growth; a favorite location is in sheltered mountain basins. Several of the best known groves are preserved in the California State Redwood Park (known as the "Big Basin") in Santa Cruz county, and the Muir Grove in Marin county. Redwood lumber is used for building purposes and making shingles.

The Big Trees bear the distinction of being among the rarest as well as the most impressive of all living species of trees. They are found only in a few groves of the Sierras, fortunately many of these having been secured and protected as national parks and forests such as in Yosemite and Sequoia National Parks, the Sierra National Forest. Big Trees have foliage which is quite different from that of the Redwoods, the overlapping scale-like leaves resembling those of cypresses. The cones are about twice the size of the Redwood cones. The squat and massive trunks are of greater diameter and less height. The General Sherman tree, said to be the largest and oldest living thing, is in Sequoia National Park. Its age is estimated at three thousand years. The age of Sequoias has been a favorite subject for conjecture for decades, often it has been much overestimated. That of the Redwoods is fairly well known from studies of the annual rings of trees cut for lumber; it varies between five hundred and fifteen hundred years. The Big Trees are longer lived, many specimens recording over two thousand annual rings. The diameter of the General Sherman tree is thirty-six feet, its full height two hundred and seventy-two feet. Engineers have estimated that there are over half a million board feet of lumber in this one tree. A hunter and trapper, discovering it in 1879, named it after the general under whom he had served in the Civil War.

One of the most valuable timber trees of the United States is the Bald Cypress, a deciduous Conifer found in a continuous belt from the south Atlantic coast states to the Gulf of Mexico. Like the Sequoia, it was in former geologic periods far more widespread in the United States than it is now. Its home is in the river swamps, where the base of the tree is frequently submerged for several months of the year. Great forests cover many hundreds of square miles in the coastal swamps, and stretch for some hundred miles through the Everglades of Florida. Unique is the development of cone-shaped "knees" which project from the root system upwards beyond the surface of the water and function as aerating organs, bringing air to the root tissues which might otherwise be suffocated by the presence of water over the root system. The Bald Cypress (*Taxodium*) has linear pointed needles about a half an inch in length, which are shed annually in autumn. The cones are nearly spherical, about an inch in diameter. The tree itself, enlarged and buttressed at the base, has a tall tapering trunk reaching a maximum height of a hundred and fifty feet. Cypress wood is used for posts, poles and railway ties; it is light and durable, being used in construction work where an easily worked wood is desirable and strength is not essential.

Cryptomeria is a Japanese tree of the Redwood family which is frequently culti-



The Bald Cypress (*Taxodium*), with enlarged and buttressed base, forms impenetrable forests in the swamplands of our southeastern states; it is a common tree of the Everglades. Highlands Hammock State Park, Sebring, Florida.

vated in southern United States. The leaves are a half an inch to an inch long, linear and with incurved tips. When fruiting it is easily recognized by the spherical bristly cones.

THE CYPRESS FAMILY

The Cypress Family (*Cupressaceae*), with its hundred and twenty species, is second in size to the Pine Family. Many of the genera are found only in Australia, China, Chile, South Africa and other widely separated countries. Some of these, such as the Cypress Pine (*Callitris*) of Australia and the Funeral Cypress (*Cupressus*) of China have become established as ornamental trees and shrubs in the United States.

A variety of Conifers are known as cedars, none of them closely related to the true cedars (*Cedrus*) of the Pine Family. One of the common eastern species is the Red Cedar, in reality a Juniper; another, known as the White Cedar, should be more appropriately called Arbor Vitae.

The genus *Juniperus* is a large one, scattered through Europe, North America, northern Asia and Africa. In all the species the leaves are short sharp needles or overlapping scales; and the fruit, instead of being a woody cone is a small berry. The Red Cedar or Savin is a slender low-growing tree or shrub common to gravelly and rocky slopes such as are found in many old New England pastures where this is a common tree. Its range is from eastern Canada to Georgia and Texas. The light, close-grained fragrant wood is often used for lining closets and making moth-proof chests. It is also used for posts, poles and other products where durability in contact with the soil is desired. The southern Red Cedar, found from Georgia south to Florida, lives in the river swamps; it is the tree which was used for years as the wood for lead pencils. The common Juniper is an evergreen shrub of the northeastern states, where it forms prickly thickets in the open pastures. The Colorado Juniper becomes a small tree; it is found in the foothills from the Rocky Mountains to the Pacific coast. The Sierra Juniper is another picturesque small tree of the mountains and mesas of the west, which has been found eking out a precarious existence among rocky ledges at altitudes of eleven thousand feet. At the other extreme, in the low desert basins, we find the California, or Desert, Juniper.

The White Cedar of the eastern states (*Chamaecyparis*) is a medium sized tree found in the coastal swamps from Maine to Florida; related species are found in the west and in Japan. The closely overlapping scale-like leaves form irregular foliage sprays which bear small spherical cones. The wood is light and close-grained, durable when in contact with the soil; hence it is ideal for fence posts and poles; it is also used for shingles and boat building. The Lawson Cypress, also called the Port Orford Cedar, is a species native to Oregon and northern California where it is a forest tree with drooping branches and flat, fern-like sprays which make this one of the most attractive of the larger Conifers.

Ornamental evergreen trees and shrubs which retain their awl-like seedling leaves are known to gardeners as *Retinospora*; some of these are varieties of *Chamaecyparis*, some of the following genus *Thuja*.

The Arbor Vitae (*Thuja*) is frequently called the White Cedar. It has the same overlapping scale-like leaves as the previous species, but the foliage sprays are usually



Foliage of Arbor Vitae (*Thuja*), showing the flattened sprays with their small overlapping needle-like leaves.

flattened in a vertical plane giving the tree a tailored and pressed appearance. Five species occur in North America and Asia, the common eastern species living in the region between Nova Scotia and the Allegheny Mountains. Partial to swampy ground, the Arbor Vitae forms impenetrable thickets in the upland sections of New York and along the coast of Maine. The wood is too coarse-grained and brittle to be used for mill work, but the resinous and decay-resisting qualities make it an ideal wood for posts and poles. In Maine and Minnesota it is the chief shingle wood. The Canoe Cedar, or Giant Arbor Vitae, is a massive tree found singly or in small groves on the moist lowlands of the Pacific coast from Alaska to California. It is the chief source of western shingles as well as being used for interior finish. The Indians split planks from this cedar for building their lodges and out of which to carve their totem poles. Some were hollowed out to form their huge war canoes, while the fibrous inner bark was utilized in making ropes and coarse blankets.

The Incense Cedar (*Libocedrus*) is a tall straight tree of distinguished appearance, reaching a size of a hundred and fifty feet and occurring from Oregon to southern California. It is an aromatic forest tree, different from the other scale-leaved evergreens in that the flattened leaf sprays are made up of small leaves arranged in cycles of four. Other species are found in South America, New Zealand, Formosa and China.

The true Cypressess belong to the genus *Cupressus*, of which there are about a dozen species in North America, Asia and Central America. The aromatic foliage shoots are made up of twigs closely covered with minute overlapping scales. The cones are small and spherical, each consisting of a dozen or more shield-shaped scales which are tightly closed in the immature cone. Familiar to the tourist is the famed Monterey Cypress of the Carmel Bay region of California, the only place in the world where this rugged, picturesque evergreen is to be found. In Arizona there is another cypress of restricted distribution, the Arizona Cypress, which grows to be a medium-sized tree, the bushy foliage sprays forming a solid covering close to the ground. The Mourning Cypress, introduced from China, has a sombre color and a classical funereal shape. Other ornamental cypressess hail from Mexico and the Himalayas.

THE ARAUCARIA FAMILY

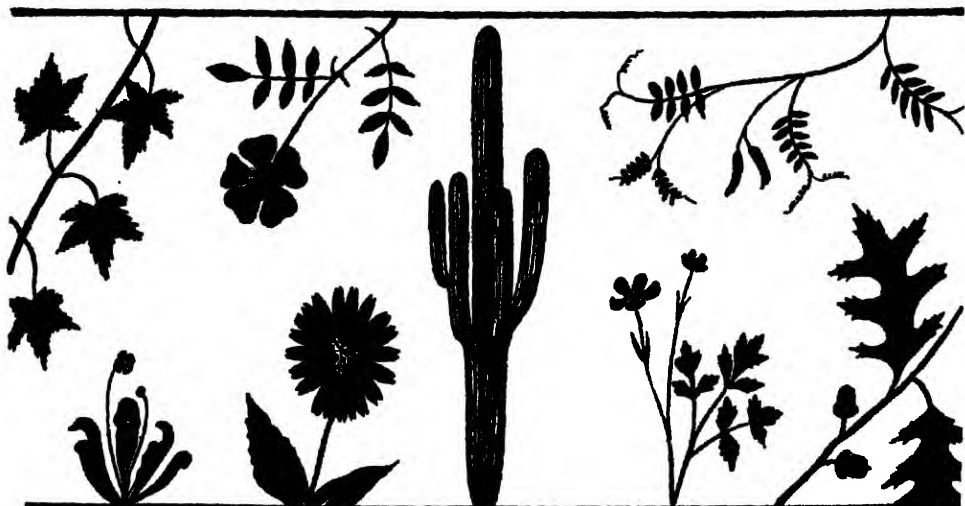
The most unusual of the exotic trees which have become commonplace sights in the parks and along the streets of California, Florida and a few other southern states, are the various species of *Araucaria*, sole representative of the family. They are symmetrical trees with whorled branches and either scale-like or flattened needles. The twelve species are found in Australia, New Guinea and Chile. The Bunya-Bunya is a tall tree with stiff flattened needles several inches long, glossy green in color and in two rows on the twigs; it has been introduced from Australia. The Monkey Puzzle Tree is a smaller species of peculiar habit; the straight central trunk has spreading stout branches in regular whorls of five, each branch covered with stiff overlapping leaves an inch or two in length. Its home is in Chile. More commonly cultivated than either of the preceding is the Norfolk Island Pine, coming from the island of that name. It grows to be a medium-sized tree, the horizontal or slightly upturned branches in regular whorls of four to seven, the small awl-shaped leaves overlapping the drooping branchlets.

These are a few of the Conifers which have established themselves in the United



The Monkey Puzzle Tree (*Araucaria imbricata*) is an Australian Conifer with stiff short leaves which completely clothe the angular branches. Pasadena, California.

States, either through thousands of years of natural adaptation or through human importation. Let us hope that after this excursion into the realm of the Conifers, the reader will at least not call all evergreen trees either "pines" or "Christmas trees"; there is no group of plants easier to learn to recognize.



SPERMATOPHYTA: ANGIOSPERM DICOTS

The FRUIT-SEED PLANTS—*Angiosperms*—represent the highest expression of plant life; so successful have they been that they today dominate the vegetation of the lands. This is due partly to the efficient body plan, with woody supporting tissues which, in some instances, guarantee a long life and results in the deciduous trees of our woodlands; and partly to the effective reproductive habits by wind- and insect-pollinated flowers and a variety of ingenious fruit-dispersal methods whereby the carefully protected seed—containing the baby plant—is brought to a suitable environment. There are two groups of *Angiosperms*. Dicots usually have flowers with four or five petals and sepals, if any at all; stems with an ability in many cases to grow in thickness by the addition of new layers of wood; and leaves with netted venation as in the maples or oaks. Some Dicots have cone-shaped reproductive structures known as catkins; others have flowers of separate petals and sepals; still others have flowers in which the petals or sepals, or both, are fused to form a cylindrical throat to the flower. It is a great range from the Catkin Plants such as the Birches, to the Composites, such as the Sunflower; yet this is the range that is found in the Dicots, as will be seen in the following chapters.

CHAPTER XII

The Catkin-Bearing Plant



THE production of seeds has been one of the reasons for the increasing dominance of Spermatophytes on land. But they all do not produce seeds in the same way. We have already become familiar with the naked-seed type, resulting from the production of pollen and ovules in cones, as in the Gymnosperms. Among the other, and far larger group of the Angiosperms, the seeds are enveloped by tissues which act as a fruit; sometimes this is fleshy as in the berries, at other times hard and dry as in the nuts. Seed is never produced unless pollen is carried from the stamen to the pistil which contains the egg. In the Conifers, the pollen and ovules are produced on the scales of cones; the pollen is dispersed by the wind, some of it eventually coming to rest on the scales of the ovule-bearing cone. After pollination, the eggs finally develop into seeds.

Among the Angiosperms, there are a few families which reproduce in an analogous fashion. The stamens are found closely packed on a short axis surrounded by loose scales, which resembles a cone, though the scales are usually small and rarely woody. This small cone-shaped reproductive organ is called a **catkin**. Sometimes the pistils are also found on such catkins. The flowers in these catkins lack the conspicuous parts known as petals or sepals, and are usually green in color. The pollen is wind-dispersed, so that pollination takes place as in the Conifers. After pollination, the seeds and fruits are formed in the pistillate catkins. These catkin-bearing flowering plants are for the most part woody shrubs and trees, many of them being the common deciduous trees of our forests. Most familiar are the Willow Family, which includes the Poplars and Willows; the Walnut Family, which includes the Hickories, Pecans, Butternuts and Walnuts; the Birch Family, with its Alders, Hazelnuts and Hornbeams in addition to the Birches; and the Beech Family with the Chestnuts, Beeches and Oaks.

THE WILLOW FAMILY

Because the Pussy Willow is eagerly sought as the harbinger of Spring, its fuzzy catkins are well known to most of us. All of the Willows do not have catkins as prominent or hairy, but they all produce staminate and pistillate flowers in catkins. The Willow Family (*Salicaceae*) are woody shrubs or trees widely distributed throughout the Northern Hemisphere; the only genera in the family are the Poplars with their broad, heart-shaped or ovate leaves and drooping catkins, and the Willows with narrower, more pointed leaves and less drooping catkins.

There are eighteen species of Poplar (*Populus*) scattered through Northern Africa, Europe and North America.—all rapidly growing trees with light greenish-gray bark (at least on the younger branches) and very soft wood. For the latter reason they are unsuited to any use except as paper pulp. Some of the species are planted along city streets and parks; they are among the few trees which have adapted themselves to the wind-swept prairies where they are a common sight. Among introduced species are the White Poplar of Asia and Europe, with deeply-lobed leaves

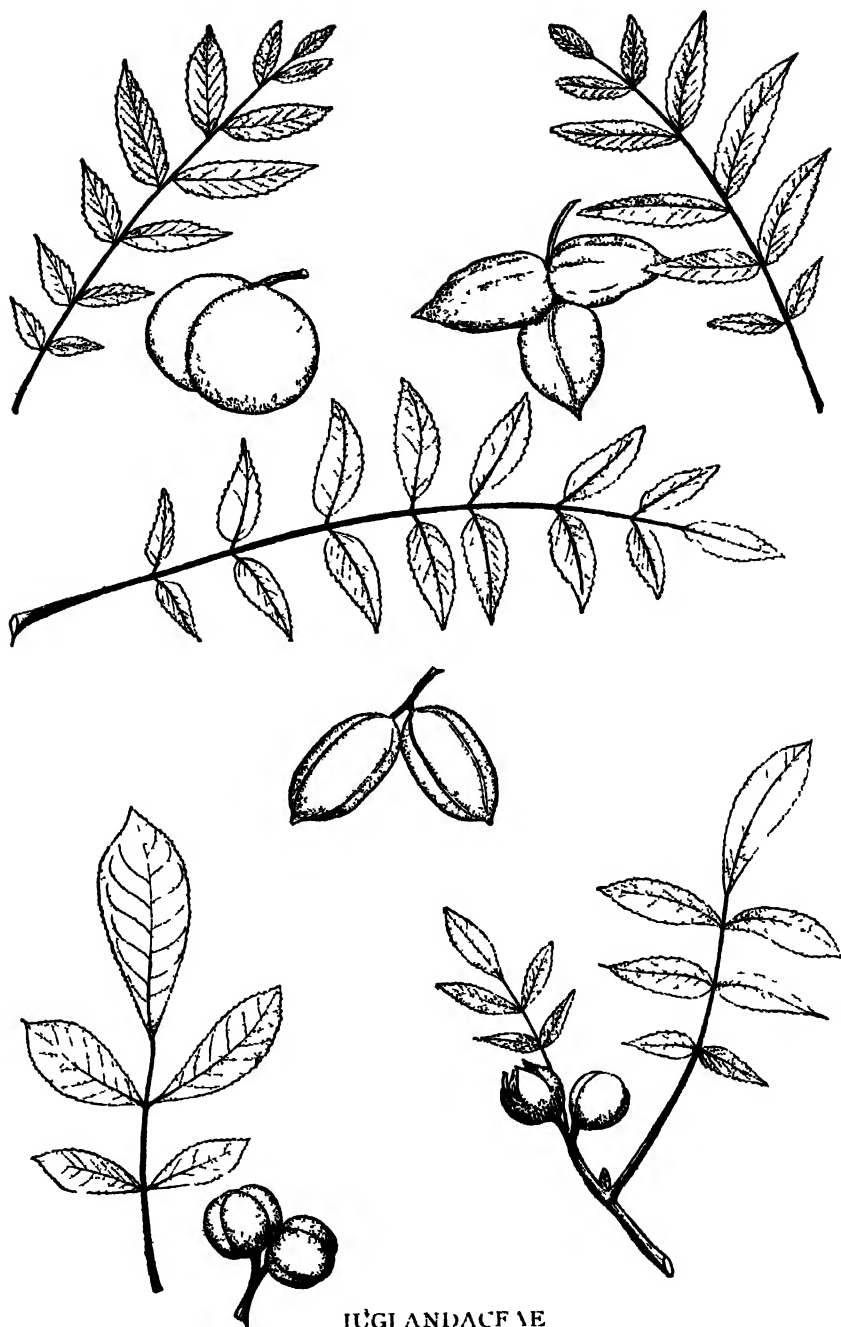


SALICACEAE

Upper Row: Quaking Aspen, Eastern Cottonwood, and Fremont Cottonwood.
Lower Row: Black Willow and Osier Willow.

hairy-white on the undersurface; the Lombardy Poplar, another introduced European species, whose tall columnar habit makes it an excellent windbreak; and the Balm of Gilead, of Asiatic origin, with leaves which are broad and heart-shaped.

Some of the Poplars have flattened leaf stalks which permit the pendulous leaves to quiver in the slightest breeze. The Quaking Aspen of the eastern states is such a tree. Because of its smooth grayish trunk it is often mistaken for a Birch or a Beech. The small leaves are round and edged with small teeth. The Large-tooth Aspen also has flattened leaf stalks; its leaves are larger with rounded teeth. This Aspen is rarely found west of Minnesota or south of North Carolina. The Eastern Cottonwood, one of the largest Poplars, also has the flattened leaf stalks; its leaves are broadly triangular with wavy margin. The pistillate trees cause unsightly streets and lawns when their quantity of cottony seeds are released. West of the Mississippi the Great Plains



JUGLANDACEAE

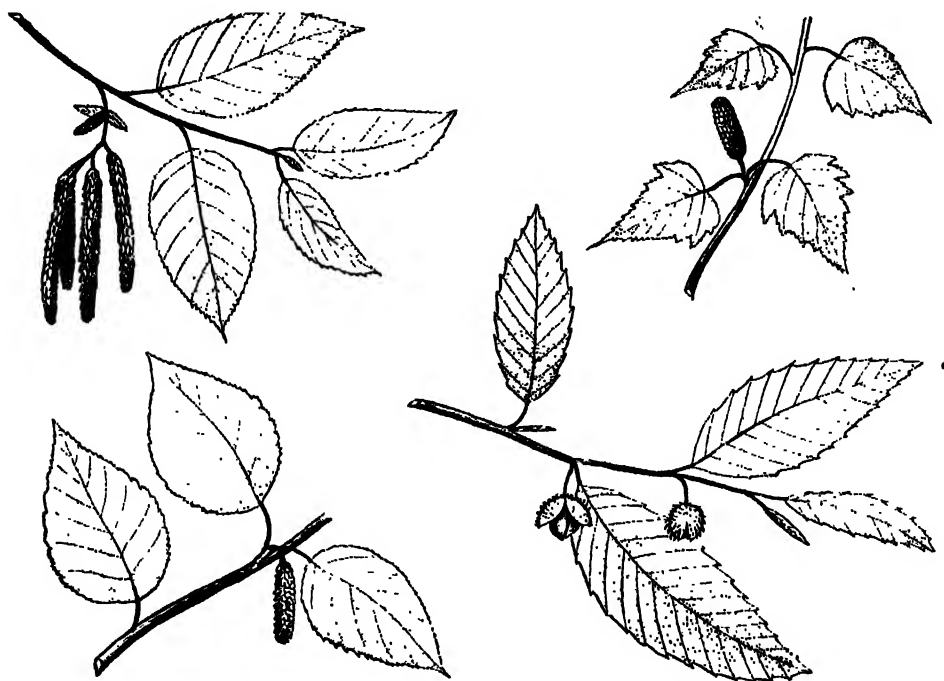
Upper Row Black Walnut, Butternut

Center Pecan

Lower Row Shagbark Hickory and Pignut

Cottonwood replaces the eastern species, and is the characteristic tree of stream beds. The Valley Cottonwood grows in similar locations in the Rio Grande country, while on the Pacific coast and in the Southwest we find the Fremont and the Black Cottonwoods. The Poplars which lack the "quaking" habit include the Downy Poplar—a medium sized tree of the river swamps of southeastern United States—and the Balsam Poplar of swamplands in the more northern states and Canada.

The Willows (*Salix*) derive their scientific name from the Celtic "sal" meaning near, and "lis" meaning water. There is perhaps no other Angiosperm tree which



BETULACEAE AND FAGACEAE

Black Birch (*upper left*), Gray Birch (*upper right*), Paper Birch (*lower left*);
American Beech.

is more commonly associated with water. Several hundred species live in the north temperate and subarctic regions, flourishing often in wet or cold ground. The Willows venture farther into the Arctic than any other woody Angiosperm; there some of the species become the smallest trees known. Economically the Willow has few uses. The Osier Willow of Europe and Asia has for centuries been made into baskets, the European White Willow has been used to prevent erosion of stream banks, and the Weeping Willow, native to China, is frequently planted in parks and gardens, decorative in its unique drooping habit.

In eastern United States, the Black Willow and the Yellow Willow are common in wet woods and swampy thickets. The Pussy Willow, recognized by its hairy gray catkins, is a more shrubby species. Some of the Willows have leaves which are felty

and white on the undersurface. Such are the Nuttall Willow, a common Pacific coast species of the mountains, and the Satin Willow, another small tree found along stream banks from Alaska to Oregon. A similar hairy undersurface to the leaves is characteristic of the Sage Willow, a shrubby species thriving in the cold bogs of Canada and northeastern United States.

In the southeastern portion of the country we find, in the rivers and swamps of the coastal plain, some species with noticeably red or purple stems: the Gulf Willow, the Sandbar Willow and the Rosemary Willow. The Midwest is the home of a willow



BETULACEAE

Hazelnut (*upper left*), Hop Hornbeam (*center*), Hoary Alder (*right*), Ironwood (*lower left*).

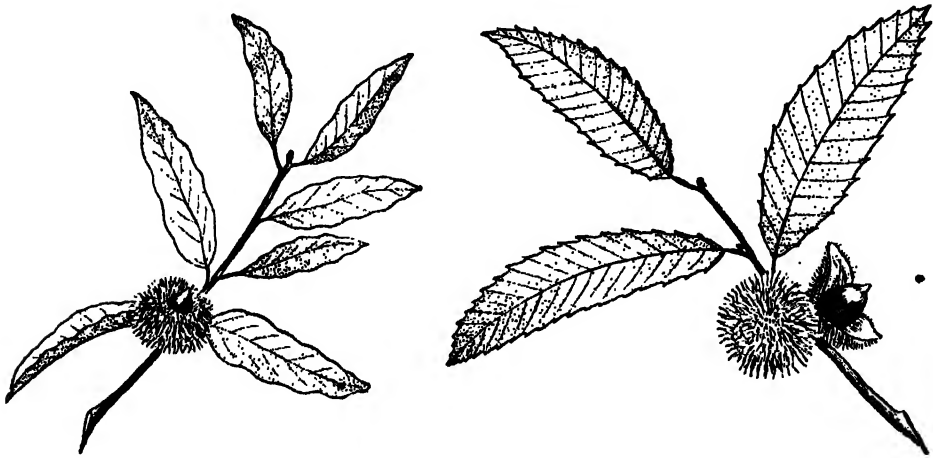
which has adapted itself to drier habitat than that of most of the other species; this is the Prairie Willow. The Peachleaf Willow, a shrubby tree widely distributed through the central and western states, has yellowish-green foliage and drooping habit. West of the mountains, along the Pacific coast, the small Arroyo Willow has made itself at home along the dry water courses; while higher up in the mountain canyons the taller Red and Yellow Willows are the common trees.

THE WALNUT FAMILY

The Walnuts (*Juglandaceae*) constitute an easily recognized family because of their large compound leaves and single seed—which is the “nut,” enclosed in a woody or leathery husk. The corrugated meaty seed-leaves of the embryo make up the edible

portion. There are about forty species distributed throughout the United States, Europe, Central America, China and Japan. The staminate flowers are in large drooping green catkins while the pistillate ones are in small clusters or spikes. The only introduced member of the family is the Chinese Wingnut (*Pterocarya*) which is an ornamental tree found along the Pacific coast. It is the wood from this tree, characterized by a mottled appearance, which is marketed as Circassian Walnut.

The Walnut (*Juglans*) gets its scientific name from the combination of classical words "Jovis" meaning Jupiter, and "glans" meaning nut. In other words, the nuts were considered food fit for the gods. In eastern and central United States there are two common species. The Black Walnut is a large tree found only in rich woods



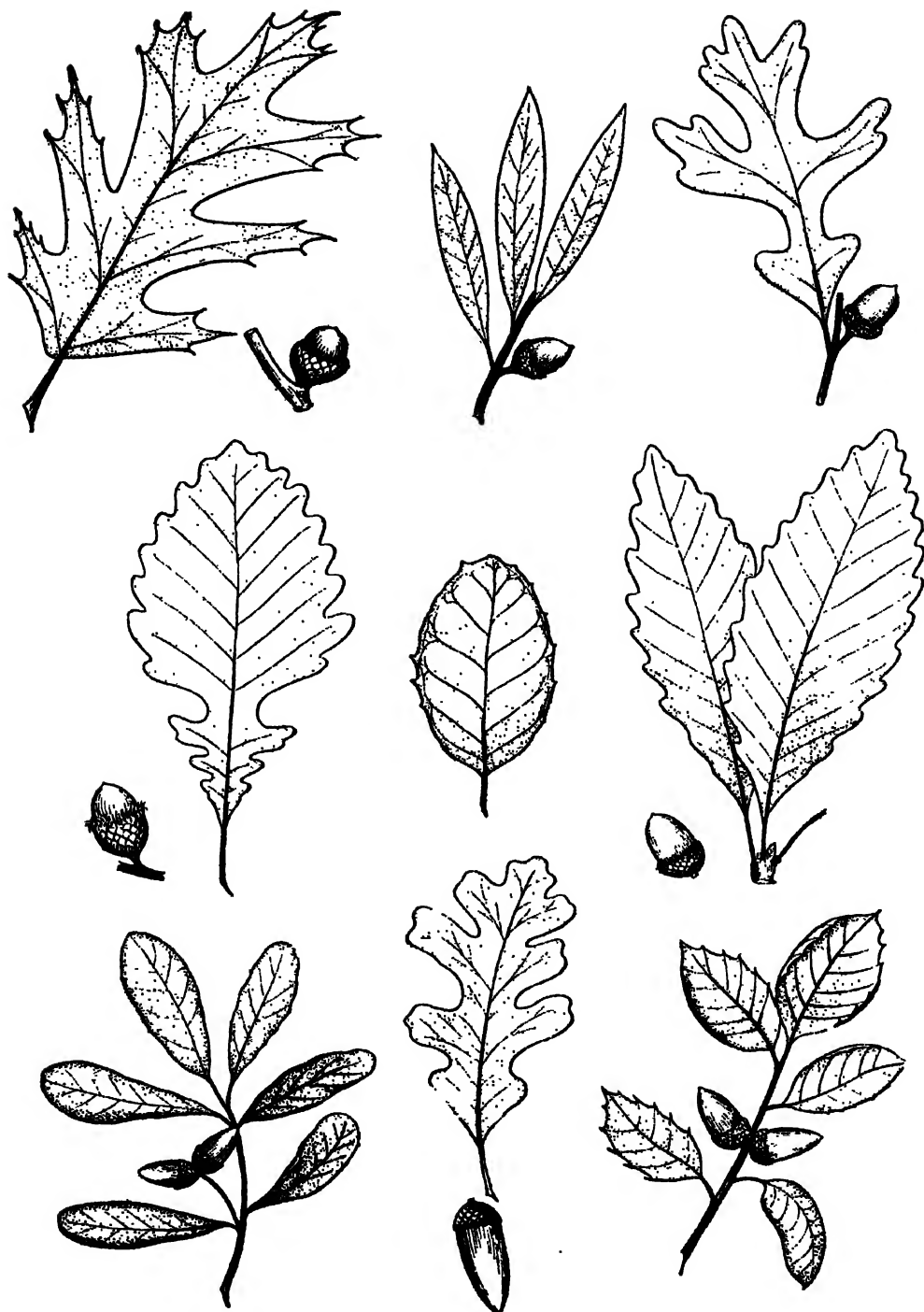
FAGACEAE

American Chestnut and Giant Chinquapin.

where it often grows to a height of a hundred feet; the leaves are subdivided into numerous small leaflets arranged on either side of the central "stem." In the Black Walnut there are fifteen to thirty-three leaflets to each compound leaf. This is a valuable lumber tree, its hard, attractively grained wood being used in furniture making. The Butternut is another eastern species, slightly smaller and with leaves usually made up of seventeen, or fewer, leaflets. Both of these have deeply fissured shells enclosed by a leathery husk which does not split open even when the edible nuts are ripe.

The English Walnut (also called the Persian Walnut) produces the large edible walnuts of commerce. The California Black Walnut is a related tree with eleven to twenty-three leaflets to a leaf; it is used as a stock on which to graft the English Walnut. Extensive groves are found in southern California. In this portion of the state, south and east of Los Angeles, walnut growing is a business involving fifty thousand acres and an investment of some fifty million dollars; an average yearly crop is twelve thousand tons of walnuts, worth three to four million dollars.

The other nut trees have smooth-shelled nuts enclosed in a husk which splits open when the nut is ripe; they are usually grouped in the genus *Carya*. Some have only



FAGACEAE

Upper Row: Black Oak, Willow Oak, White Oak.

Middle Row: Mossycup Oak, Cork Oak, Chestnut Oak.

Lower Row: Eastern Live Oak, Valley Oak, California Live Oak.

three to seven leaflets in each leaf, as the common Shagbark Hickory and Pignut Hickory of wide distribution. The Shagbark is a large rugged tree with a trunk covered with the pendant ragged strips of bark which have separated from the underlying tissues. It ranges from New England to Florida and Minnesota. The Pignut is a smaller tree with a less desirable nut, and a thicker shell. The Mockernut is a tree of rich woods found east of the Mississippi; it too has a thick-shelled nut with relatively little meat.

Most valuable of the eastern species of the Walnut Family is the Pecan. This becomes a large tree often over a hundred and fifty feet tall; the leaves are subdivided into eleven to seventeen leaflets, each five or six inches in length. The Pecan grows along river bottoms and rich woods throughout the Mississippi River valley. The shell is very thin, so that the edible contents are practically as large as the entire nut. The wild crop of Texas and Louisiana, the native home of the Pecans, has been a valuable asset to these states for the last thirty or forty years. More recently, however, cultivated areas in Georgia, Florida and South Carolina are producing the bulk of the commercial crop.

THE BIRCH FAMILY

Six genera of deciduous trees and shrubs, common to the northern hemisphere, make up the Birch Family (*Betulaceae*); five of these are native to the United States, while the remaining genus is found only in Mongolia. •

The Birches (*Betula*) are for the most part short-lived trees with simple and entire leaves. The staminate catkins, as they elongate and mature, become pendulous; but the pistillate catkins remain stiff and cone-like, closely attached to the twigs. The smooth, often satiny, bark is marked by horizontally elongated lines which act as special enlarged air pores. Air pores (lenticels) are found on the bark of younger branches of all trees, acting as breathing openings for the tree. In some species the bark peels off in thin papery strips. The Birches are our most beautiful forest trees, often found mingled with the evergreen in our northern coniferous forests. Of the thirty-five known species, nine are native to the United States. The close-grained, hard wood is used in furniture making; much of the so-called mahogany in lower priced furniture is in reality stained Yellow Birch. The aromatic bark of the Black Birch yields the commercial oil of wintergreen; while the sap-filled twigs of various eastern species is used in making the beverage known as birch beer. Paper Birch furnished the material used by eastern Indians in making their birch-bark canoes.

The white-barked Birches are often used as ornamental trees. The White Birch of Europe has firm white bark and drooping branches like those of a Weeping Willow. The Canoe or Paper Birch is a closely related species found in Canada and the northern tier of states, from Washington to Maine; it has leaves more heart-shaped than the broadly triangular ones of the White Birch. The chalky white bark peels into thin strips; if removed it not only defaces the tree but may endanger the tree's life by injuring the sensitive and vitally important sapwood just underneath. The common Gray Birch of New England and nearby states is a smaller tree found on poor and rocky soil, especially of abandoned pastures, where it is a companion to the Red Cedar. The trees are shallow rooted and find difficulty in maintaining an erect position; the leaning groups of Birches make picturesque clumps in open wood-



The flowers of Poplars (*Populus*) are pendint catkins, which decorate the branches as soon as the leaves begin to appear. Hamilton, N. Y.

lands. The bark varies from a sooty gray (not chalky or peeling) to reddish-brown on the smaller branches.

The darker colored Birches of the eastern states include the aromatic-barked Black Birch, found in rich woods from Canada to Delaware and Indiana. The smooth black bark is conspicuously marked with the numerous horizontal lenticels. The River or Red Birch is found more commonly along streams and has greenish-brown bark. The Yellow or Silver Birch has satiny, golden-brown bark which shreds into thin papery strips.

West of the Rocky Mountains there is a slender little tree known as the Mountain Birch with shiny reddish-brown bark and small ovate leaves. Farther to the north, the trees become smaller and dwarfed; the Swamp Birch is a shrubby tree of cold bogs in Canada and the northern states, while the Arctic Birch is a low spreading shrub of subarctic and arctic North America and Europe.

The Hornbeam or Ironwood (*Carpinus*) is a shrub or tree of northeastern United States, characterized by small oval leaves and firm gray bark. There is an introduced species, native to Europe, which is cultivated in various states. The Hop Hornbeam (*Ostrya*) is a small tree of similar habit but of slightly more extensive range to the south and west; its bark is browner and often furrowed.

The Hazelnut (*Corylus*) is a shrub, sometimes a small tree, which is known by the edible nuts which are enclosed in a leafy husk. It is this fringed husk which gives the plant its scientific name; "korys" being the Greek name for helmet, referring to the protective husks around the nut. In California a European species, the Giant Filbert, is cultivated for the large tasty nut.

The Alders (*Alnus*) include shrubs and small trees restricted to mountains, river beds, and swamps. The common Hoary Alder forms dense clumps and thickets in the swamplands of eastern and central United States. The Smooth Alder grows in similar locations along the coastal plain and is the characteristic Alder of Florida and adjacent states. The western species include the shrubby Sitka Alder found in high mountains from Alaska to California; the Mountain Alder of the alpine meadows in the Sierras and Cascade ranges; the Red Alder, a medium-sized tree of the stream banks and shore flats; and the tall White Alder, most tree-like of the whole genus, reaching a height of eighty feet. This species ranges from sea level to altitudes of seven thousand feet on the mountain ranges of the Pacific coast.

THE BEECH FAMILY

This family (*Fagaceae*) includes by far the greatest number of catkin-bearing trees. Of the seven known genera in the family, five are native to the United States; the other two occur in the Australian and Pacific Islands region.

The Beech (*Fagus*) is a small genus of deciduous trees found in Europe, Asia and North America. The scientific name of the Beeches comes from the Greek word "phagein" meaning to eat, designating the edible nut. The American Beech grows in rich soil in all of the states east of the Mississippi and as far south as Virginia. The tree has firm, smooth gray bark, leaves which are long and pointed, provided with regularly spaced large teeth along the margin; and as fruit, a small triangular nut protected by a spiny burr. The Copper Beech is a species introduced from Europe, and considered a prized ornamental tree because of its reddish-brown foliage.



The fluffy catkins of the Pussy Willow (*Salix discolor*) are among the first flowers of spring. Hamilton, N. Y.

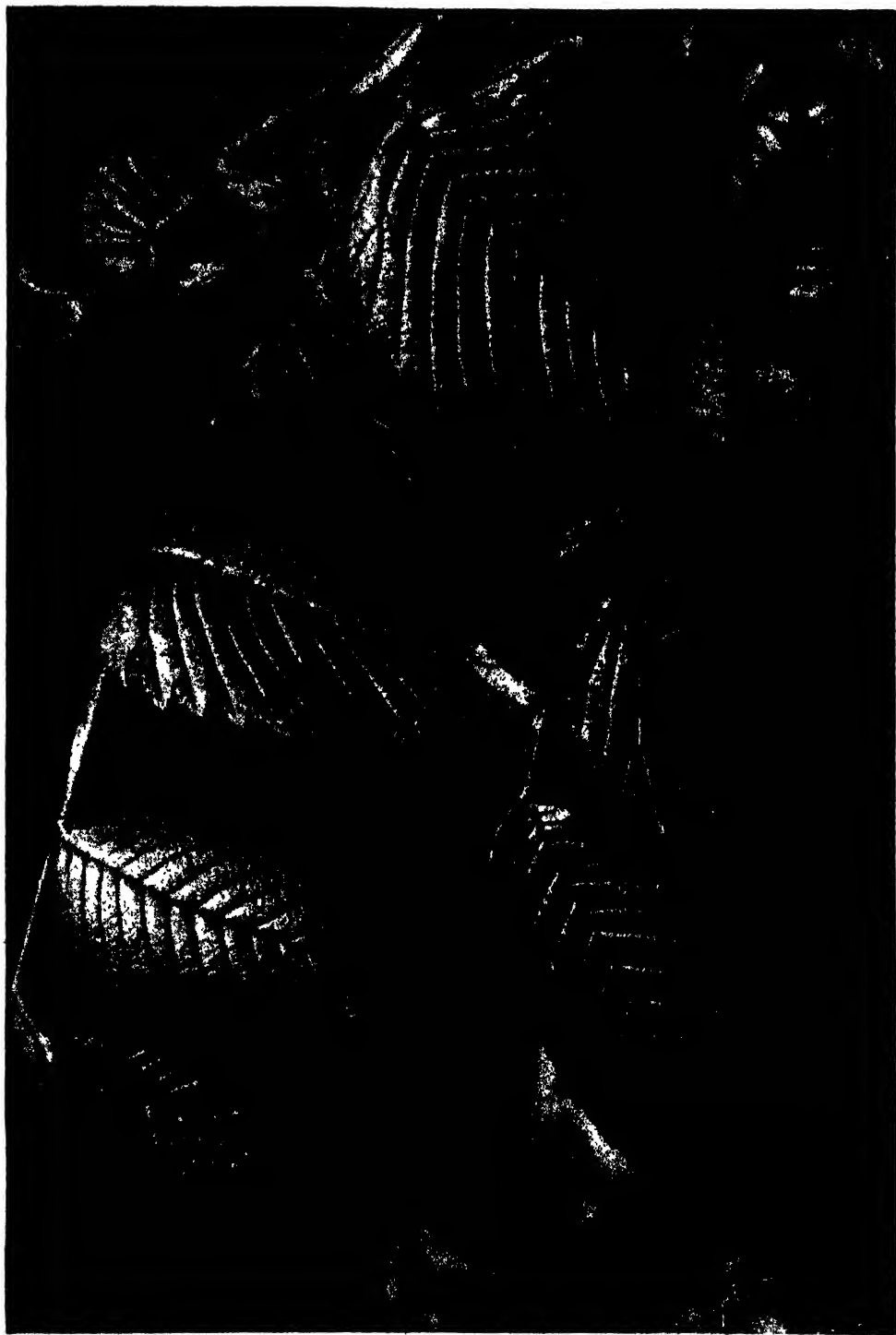
The Chestnut (*Castanea*) genus includes thirty species common to North America, Europe, China and Africa. The American Chestnut has large elliptical pointed leaves, prominently toothed like the Beech; and smooth-skinned edible nuts surrounded by a spiny husk. This was once a widely distributed forest tree of New England and nearby states; there it was a large and impressive tree valuable as a source of wood for furniture, poles, railway ties and tanning substances. In 1904 a parasitic fungus, the Chestnut Blight, began its attacks upon the tree, nearly exterminating it in its entire range. Eastern forests are still full of standing chestnut trunks, bleached reminders of the ravages of this fungus. A more shrubby species known as the Chinquapin is found in the dry woods south of New Jersey; four other Chinquapins grow in the sandy woodlands of the coastal plain from Florida to Texas.

The Tanbark Oak (*Lithocarpus*) of the Pacific coast is common to the Redwood forest areas. The leaves are like the Chestnuts, but the fruit is an acorn-like nut contained in a hairy cup. Another isolated species of the West is the Giant Chinquapin (*Castanopsis*) which grows on the slopes of the Pacific coastal ranges; like the Tanbark Oak, it is an evergreen.

The true Oaks (*Quercus*) include several hundred species of slow-growing, long-lived trees, the northern varieties being deciduous while some of the southern and southwestern ones are evergreen. They are found in North America, Europe and Asia. The name is the one used by the ancient Romans for the species of the Mediterranean area. Oaks are majestic and noble trees, noted for their sturdiness and the durability of their wood. The flowers, as in the other genera of the family, are in catkins; the staminate ones drooping while the pistillate are solitary, producing as a fruit the well-known acorn. The leaves vary, some being entire, others being lobed or bristle-tipped. They are the most important Angiosperm timber tree. The lumber of many species is used for furniture and building materials, since the wood is hard and at the same time beautifully grained. In addition the bark is used in tanning leather. The Cork Oak of the Mediterranean region, sometimes cultivated as an ornamental tree in the United States, is the source of commercial cork. Cork is a plant tissue produced in the bark of most woody plants as a protection for the underlying tissues; but very few trees produce cork which has the elastic qualities essential in the commercial substance. In the Cork Oak this bark tissue is thick enough to be cut in slabs several inches thick; twenty-year-old trees can be thus treated, the bark being carefully stripped off so as not to injure the growing tissues underneath. Sufficient bark growth takes place so that the cork can be removed at ten-year intervals. The cork is used for bottle stoppers and life preservers; more recent uses include packing material and linoleum.

The Oaks can be conveniently grouped into four kinds: the evergreen Live Oaks, the southern Laurel Oaks (some deciduous, some evergreen), White Oaks, and Black Oaks.

The Live Oaks are a conspicuous feature of the vegetation in the South and Southwest. From Virginia to Texas, along the highways, lining the long drives to the stately plantation homes, arching over the city streets, are the numerous representatives of the common Virginia Live Oak. This low-branched, spreading tree has dark green foliage made up of elliptical, glossy leaves with smooth margin. The rough bark of the older trees (many of them two to five centuries old) offers an ex-



Birch (*Betula*) leaves are typical of the broad thin leaves of deciduous trees. Hamilton, N. Y.

cellent anchorage for epiphytes, which bedeck the trees with a tangle of Air Plants and draperies of gray Spanish Moss. The Twin Live Oak is a more shrubby tree with stiff leaves, hairy on their under surface; it thrives among the Slash Pine on the sandy ridges from the Carolinas to Florida. The Scrub Live Oak is another tree of the southeastern coastal region, its leaves being often three-lobed at the apex. The Live Oaks of the Southwest and the Pacific coast include different species. The California Live Oak, or Encina, is a tree some fifty feet in height, with a broad dense crown which spreads out horizontally and irregularly, often touching the ground. The stiff, leathery leaves are oval and—like most of the western Live Oaks—often spiny edged. This oak is common in all the coast foothills and valley flats. Farther inland in California the common tree is the Interior Live Oak, with the same spiny oblong leaves. Other Live Oaks include the Mesa Oak, a small tree with conspicuous blue-green foliage; the shrubby Canyon Oak of the mountain canyons of Arizona, New Mexico and California; and the rich dark green Holly Oak, a European importation with holly-like leaves.

The Laurel Oaks are found on the southeastern coastal plain, extending west to Texas. The Laurel Oak is a large tree of rich woods; its leaves are entire and deep green in color. In the southern portion of its range it is evergreen. A closely related species is the Water Oak of sandy swamps and river bottoms; the leaves of this tree may also be three-lobed at the apex like the Scrub Live Oak. The Willow Oak has more linear leaves; it too is found in the vicinity of swamps and streams.

The deciduous White Oaks have leaves which are smoothly lobed, never bristle-tipped. The common White Oak of the eastern states is a large tree with grayish bark and leaves provided with five to nine rounded lobes. The Post Oak has similarly lobed leaves, but the upper lobes are broad and notched; it is a tree of sandy and rocky ridges. The Mossycup Oak, found from Canada to Texas, is a medium-sized tree with unusually bristly cups surrounding the acorn. Several of the White Oak group have leaves which are not deeply lobed, but instead are edged with rounded teeth so that the leaves have a superficial resemblance to the Chestnuts; an example of this kind of oak is the Chestnut Oak, found on rocky hillsides from New England to Florida. The western species of the White Oak group are not quite as numerous. There is the Blue Oak, a small tree of the rocky foothills of California; recognized by the shallowly lobed leaves which are bluish-green on the upper surface, hairy white underneath. The Valley Oak, or Roble, is a large graceful tree attaining a height of over a hundred feet. It is one of the most characteristic trees of the Great Valley of California. The Oregon Oak, a tree half the size of the preceding species, is common to all the Pacific coast states.

The Black Oak group is characterized by lobed leaves with sharp outlines, and a spiny projection at the point of each lobe. The Red Oak, the Scarlet Oak and the Black Oak of the eastern half of the United States all look much alike in their leaf characters and general habit; they are the common species of this group. There is in addition the smaller Pin Oak, common to the lower ground of the eastern coastal plain; its leaves are very deeply cut into narrow lobes. The Bear Oak, a dwarf tree of the sandy barrens south to Kentucky, is more sparingly lobed than most of the oaks, the wedge-shaped leaves being divided into three to seven large pointed lobes. Some of these are cultivated in the western states, where the only native species is



The common broad-leaved tree of southwestern hillsides is the Live Oak (*Quercus agrifolia*), whose low rounded crowns dot the grassy slopes with masses of rich green. Near Los Angeles, Calif.

the California Black Oak, a medium-sized tree of the lower mountain slopes of Oregon and California.

THE BEEFWOOD FAMILY

Australia is the native home of this small family of unusual Angiosperm trees, which show some affinity to the Gymnosperms. The Beefwood Family (*Casuarinaceae*) includes but a single genus (*Casuarina*) with some twenty species. They are slender-branched, open-topped trees easily mistaken for pines; but what at first sight looks like long drooping needles are in reality leafless green stems, which are jointed and marked with whorls of useless scale-like leaves after the fashion of *Equisetum* or *Ephedra*. The scientific name may be derived from "casuarius" showing a similarity to the drooping feathers of the Cassowary. The common name of Beefwood refers to the reddish wood; they are also called Horsetail Trees. The reproductive organs form club-shaped or globose catkins.

Because of their rapid growth in sandy soils, they have successfully made themselves at home in California and Florida. Three species are fairly common in cultivation. In Florida they are planted in rows, reaching a height of fifty feet and offering a splendid windbreak for the citrus groves. In California they are less common as a roadside tree, but are frequently found in parks and gardens.

OTHER CATKIN-BEARING FAMILIES

The arid Southwest is the home of a small order of evergreen shrubs and trees which includes one family, the Silk Tassels (*Garryaceae*), with one genus. The plants have leaves which are conspicuously silky and hairy on their under surface. The flowers are in catkins. The Silk Tassel Bush (*Garrya*) or Bear Brush lives on the dry slopes of the foothills of lower California and adjacent states. The showy catkins make them of occasional interest as an ornamental plant.

Along the seashores of California and Florida there grows a maritime shrub which is the lone species in its family (*Batidaceae*) and order. This is *Batis*, elsewhere found only in Hawaii. The shrub is one to three feet high, covered with fleshy leaves; the flowers are in catkins which are crowded on a terminal spike.

The Corkwood Family (*Leitneriaceae*) is also the sole family in its order, and has but one genus, the Corkwood (*Leitneria*) of our southeastern states. It is a shrubby tree of Florida and Georgia, found in the swamplands. The wood is sometimes used for floats for fishing nets, since it is lighter than cork.

The Bayberry Family (*Myricaceae*) is represented by a single genus (*Myrica*) with some thirty species found in the northern hemisphere. The leaves of some species are very spicy and fragrant when crushed, the foliage is fern-like in appearance. The Sweet Gale is a northeastern species forming shrubby growths in open pastures and woodlands. The Bayberry is a larger shrub of the coastal plains, as far south as Florida. The California Myrtle is a western cousin. The spherical berries of some species are covered with a waxy bloom which is utilized in making bayberry candles.



The Beefwood Trees (*Casuarina*) are unusual Australian trees planted in our southern states, the drooping green twigs, lacking leaves, give the effect of a wilted long-needled pine Indian River, Florida

CHAPTER XIII

The Elm Family and Its Relatives



THERE are a number of Angiosperm families which form an intermediate group between the catkin-bearing plants of the previous chapter and the plants with colored petals or sepals. These include the Elm Family, the Mulberry Family, the Lizard's-tail Family, the Nettle Family, the Pepper Family, the Buckwheat Family and the Goosefoot Family. The last two are the subject of the following chapter; all the others are treated here.

THE ELM FAMILY

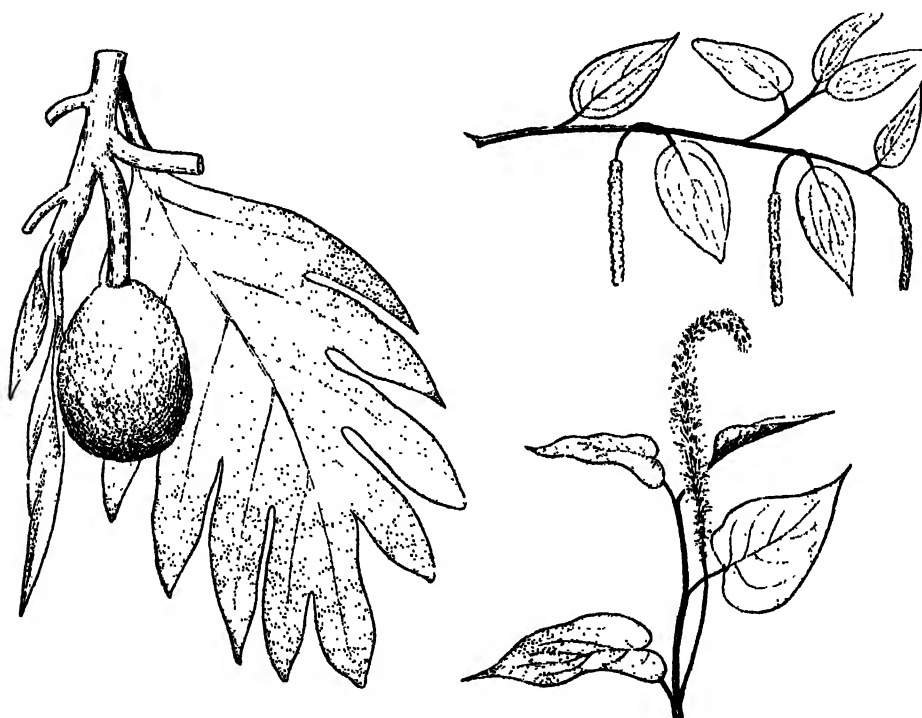
The Elm Family (*Ulmaceae*) includes trees with elliptical toothed leaves and purple or green flowers in small clusters in their axils. There is an inconspicuous set of lobed sepals at the base of the stamens and pistils. The seeds are edged with a "wing" to aid in their dispersal by the wind. The Elms (*Ulmus*) include eighteen species which are found in various north temperate countries. The graceful White Elm is a characteristic tree of the eastern states; its tall main trunk and branches diverging upwards form a vase-like spreading crown. This elm is a tree of river bottoms, banks of streams and rich hillsides; but it is more commonly thought of as a setting for the village greens and quiet streets of many New England towns where century-old elms form a canopy over houses and pavements. The Rock Elm is a smaller and more northern tree found in the states bordering Canada, as far west as Nebraska; it thrives on rocky slopes and dry uplands. Another elm of the northeastern states is the Slippery Elm, a medium-sized tree growing along stream banks especially in the St. Lawrence valley. The Winged Elm or Wahoo is a tree of dry rocky uplands rather than river lowlands; it ranges from Virginia and Indiana south to Texas and Florida. The twigs have thin corky outgrowths which spread like wings on either side of the branches. None of the elms are native west of the Rocky Mountains. A related genus is the Water Elm (*Planera*), a small tree of the swamplands of the southern coastal plain.

The Hackberries (*Celtis*) are a large genus of fifty or sixty species. The common Hackberry or Sugarberry is a small tree with ovate pointed leaves, toothed as are those of the elms. It prefers the rich slopes and bottom lands of the region from New England south and west to Georgia and the Dakotas. In the southern states there is

also the Georgia Hackberry and the Mississippi Hackberry; while in the Southwest we find the Paloblanco, a small tree of gravelly washes. The Hackberry has adapted itself even to semi-desert conditions, a spiny species being common among the cacti of the Sahuaro forest of Arizona.

THE MULBERRY FAMILY

The Mulberry Family (*Moraceae*) includes trees, vines and shrubs with a milky juice and simple leaves which may be smooth-edged, toothed or lobed. In the United States the family is represented by the Mulberries, Osage Orange and Figs; other interest-



MORACEAE, PIPERACEAE AND SAURURACEAE

Breadfruit; Pepper (*upper right*); Lizard's Tail (*lower right*).

ing members of the family are the Banyan Tree, India Rubber Plant and the Breadfruit Tree.

The Mulberry Tree (*Morus*) has inconspicuous flowers in small catkin-like structures, the pistillate ones developing into a fleshy fruit which resembles a blackberry. The Red Mulberry is a medium-sized tree growing on rich soil, and native to the region between western New England and Oklahoma. The leaves are oval or round, toothed and sometimes lobed. Another species, the Mexican Mulberry, is found in the mountain canyons of Texas, New Mexico and Arizona. The mulberry leaf used as food for the silkworm larvae in Japan is the White Mulberry. In 1631 White Mulberry trees were introduced into Virginia in an attempt to start the silk industry in

this country; later similar attempts were made in the Carolinas, Georgia and Connecticut. After many failures, the idea was at last given up; in order to carry on the silkworm business profitably, there must be plenty of cheap labor for the care of the silkworm larvae.

The Osage Orange (*Maclura*) is a small tree whose younger branches are frequently tinged with orange. It is native to the river valleys of Oklahoma, Missouri and Texas, but planted as a hedge tree in the central and southeastern states. The pistillate flowers, themselves small and green, are clustered in spherical heads which form a massive fruit whose exterior has a rough surface. The wood is used for fence posts and railway ties; it was the favorite material for the war clubs of the Osage Indians. The bark of the root furnishes a yellow dye while that of the trunk is sometimes used for tanning.



ULMACEAE

White Elm, Wahoo or Winged Elm, Hackberry.

The Breadfruit Tree (*Artocarpus*) is one of the many plants which have made history; it was the indirect cause of the now famous voyage of Captain Bligh to the South Sea Islands, and of the mutiny on his ship, the *Bounty*. The Breadfruit Tree is a tropical tree found in the Polynesian Islands, where the globular fleshy fruits are a staple part of the native diet. The King of England was interested in transplanting these trees to the West Indies, and sent Captain Bligh on an expedition to bring back several thousand living specimens. After the first ill-fated trip, the captain made a second voyage; this time he returned with over a thousand young trees. But the fruit never became as useful to the English as had been hoped.

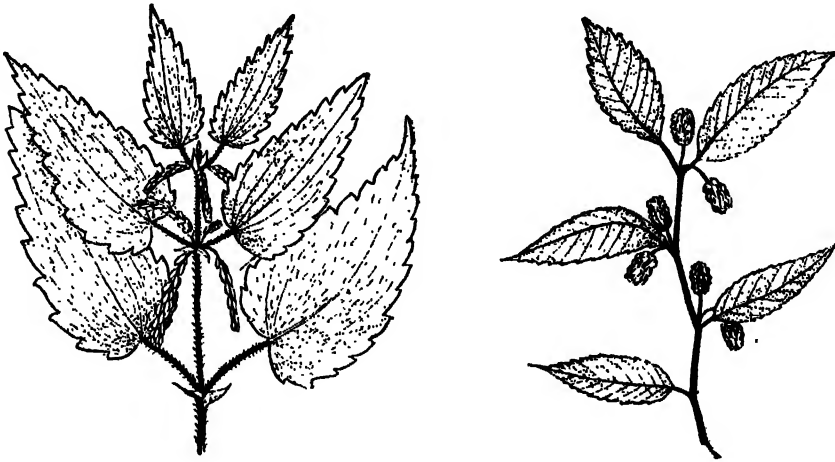
Figs constitute a large genus (*Ficus*) with at least six hundred species scattered throughout the warmer parts of the earth; the greatest number of species occur in the islands of the Pacific Ocean. Our only native species are the Strangler Fig and Wild Banyan, both restricted to the sub-tropical tip of Florida. The Strangler Fig, also called the Golden Fig, is a plant with the peculiar habit of beginning its existence



The American Elm (*Ulmus*) is a characteristic tree of the eastern states, where its tapering vase-shaped trunk and branches dot the open hillsides and form vaulted roofs over New England streets. Central New York.

as an epiphyte on some other tree, often on a palm. As the Fig grows it sends down snake-like "strangling" roots which in time completely encircle the host, and become rooted in the ground; the vine then becomes a real tree. This Fig often grows higher than its host; and after the inevitable death of the latter, the giant climber may remain as a spiral growth around a hollow cylinder. The Strangler Fig has thick yellowish-green oblong leaves often six inches long. Another species, the Wild Banyan, is also epiphytic when young, but usually does not harm its host.

The true Banyan Tree of tropical Asia, another species of *Ficus*, is one of the wonders of the plant world. From some of the branches of the young tree aerial roots grow directly downwards, force their way into the soil and thus make new trunks. In the Calcutta botanical gardens there is a hundred-year-old Banyan which began its epiphytic growth in the top of a Date Palm; today the palm is gone and in its place



URTICACEAE AND ULMACEAE

Stinging Nettle; Water Elm.

is a Banyan Tree with a main trunk some twelve feet in diameter and two hundred additional trunks, covering an area almost nine hundred feet in circumference. In this case it is hard to say whether it is a tree or a forest. Alexander the Great is said to have camped under a Banyan Tree which was big enough to shelter his whole army of seven thousand men.

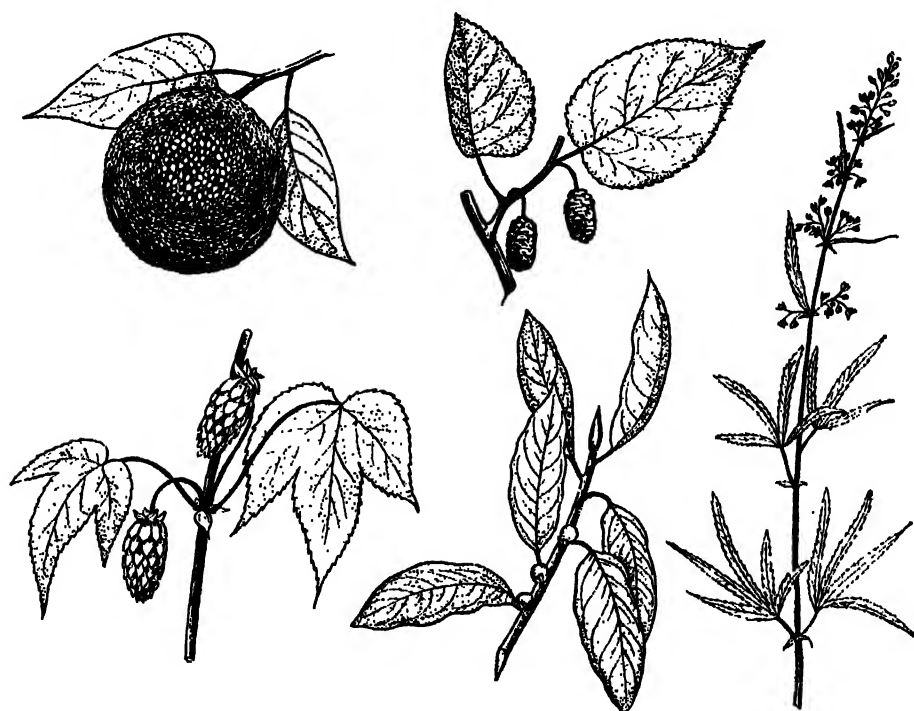
Another species of the Fig genus is the common India Rubber plant, a household favorite because of its adaptability and thick leathery glossy green leaves.

The edible Fig comes from a species common to the Mediterranean region; it is a small tree with lobed leaves, and unlike most of the Figs, never lives as an epiphyte. The flowers are produced on the inside of a hollow, pear-shaped structure; the fruit is therefore in reality a fleshy hollow receptacle with all the true fruits and seeds borne on the inner surface. Figs have been under cultivation in the Old World since before 3000 B. C., and the fruit has figured in the history of the peoples of Asia Minor for centuries. Figs were cultivated in California over a hundred years ago, many fig



The Strangling Fig (*Ficus aurea*) with its woody twining stems looks like some huge constricting snake as it encircles the unfortunate Cabbage Palm. Merritt Island, Florida.

trees having been grown in the various Mission gardens. At the Santa Clara Mission there were such trees in 1792. The growing of figs illustrates dramatically the interdependence of plants and animals. When the edible Smyrna Fig trees were first introduced into California, they produced no fruit; the American growers were unfamiliar with the fact that a particular kind of insect was needed in order to pollinate the seed-forming flowers in their receptacle. When the growers were told that the Asia Minor Greeks depended upon a small wasp to produce their fruit, they thought it



MORACEAE

Osage Orange and Red Mulberry (*upper row*); Hops, Strangler Fig Hemp
(*lower row*).

a good story. When it was finally realized that the wild Capri Fig, with inedible fruit, contained within itself the larvae of the fig-wasps necessary for the pollination of Smyrna Figs, the growers tried to import Capri Figs with their precious wasps; but by that time the Mediterranean growers put every obstacle in the path of the importing of these necessary insects. At last, after chance establishment of the fig-wasp and its young at Modesto, California, in 1869 the industry was able to get off to a successful start. Today the little fig-wasp is raised and cared for with solicitude by the Californians, for upon it depends the proper pollination of the fig trees and the resulting crop of edible fruits.

The Hemp Plant (*Cannabis*) is another valuable genus in this family. It is a stout annual plant, originally from central Asia but now found thriving on waste

THE NETTLE FAMILY

This family (*Urticaceae*) includes the common Stinging Nettle (*Urtica*), annual and perennial herbs of our eastern states. The flowers are all inconspicuous and greenish; the leaves have hairs which upon contact produce an unpleasant stinging sensation. The Ramie Plant (*Boehmeria*) is a shrub native to Asia which has established itself in waste places of Florida and near-by states. Its fibers, known as ramie, are of some economic value.

CHAPTER XIV

The Buckwheat and Goosefoot Families



IN THESE two families of inconspicuously flowered plants there are plants of widely varying habits and value; many of them are obnoxious weeds while others are used as food. In the Buckwheat Family there are such common flowering weeds as Smartweed, Tearthumb, Dock and Sorrel; some tropical trees as the Sea Grape; Buckwheat and Rhubarb. In the Goosefoot Family there are Glasswort, Goosefoot, Salthush, Saltwort and Greasewood; and the food plants Beets, Chard and Spinach.

THE BUCKWHEAT FAMILY

This family (*Polygonaceae*) of herbaceous and shrubby plants is characterized by entire and simple leaves, stems conspicuously jointed and often swollen at the nodes, and small flowers which have a calyx but no corolla.

The Sulphur Flower genus (*Eriogonum*) includes a great number of woolly-leaved plants found on the deserts, plains, mesas and mountain slopes of the western states. The yellow or pink flowers are in terminal clusters. In the Southwest we find, among many other species, the Desert Trumpet, St. Catharine's Lace and California Buckwheat. A related genus (*Chorizanthe*) has some twenty species in the same area as the *Eriogonums*.

Dock, or Sorrel (*Rumex*), is a coarse plant with small greenish flowers clustered at the tips of the stems. The leaves, in many of the species, are basal, from them arising the flowering stalk-bearing flowers with a six-parted calyx often colored pink or yellow. There are over a hundred species in various countries throughout the world, many of them established as weeds around abandoned dwellings. Of the American species we might mention the tall and stout Water Dock of our northeastern states, the smaller Golden Dock of seashores along the Atlantic coast, the Curly or Yellow Dock, an immigrant from Europe which is now very much at home in waste lands, and that ubiquitous weed Sheep Sorrel. The last-named species has reddish or yellow flowers and unusual spear-shaped leaves with two diverging basal lobes. The leaves of one species, the Spinach Dock, are eaten as greens.

The Smartweeds (*Persicaria*) are small plants a foot or two in height, some of them native and others naturalized. The flowers, clustered in dense terminal spikes, have conspicuous bright rose-red sepals. Many of the species are partial to wet

meadows and swamps. The Tearthumbs (*Tracaulon*) are weak-stemmed climbing plants with prickly stems which have given them their common name. They also have rose-colored flowers, but in spikes less dense than the Smartweeds.

The only tree member of the family in the United States is *Coccoloba*, whose two species are found only in southern Florida. The Sea Grape is a stoutly branched tree of the sandy seashores where it often forms thickets beneath Cabbage and Coconut Palms. The leaves are large and rounded, with prominent red midribs. The Pigeon Plum, with smaller leaves, grows to be a larger tree.

Rhubarb, or Pieplant (*Rheum*), is a well-known member of all farm gardens. It has been in cultivation since prehistoric times,—so long that no one is sure of its ancestral home. It may have come from eastern Europe or western Asia. The large



POLYGONACEAE

Sheep Sorrel, Buckwheat, Smartweed.

coarse leaves are borne on reddish-green leaf stalks which are cooked or used as a juice for wine. The large woody underground stem (rhizome) of some species contains medicinal substances and is used by pharmacists. The edible species grow in southern Siberia; related varieties are native to Syria and China.

Buckwheat (*Fagopyrum*) gets its scientific name from the likeness of its fruit to a small beechnut; *fagopyrum* literally means beech-wheat. The only two known species are native to Europe and northern Asia. Buckwheat is an annual plant several feet in height, with succulent and much-branched stems. Each of the small white flowers forms a fruit which is triangular and brownish-black. The stored food contained in the large single seed is richer in starch than are other cereal grains. Buckwheat has been cultivated by the Chinese for the past thousand years, and from there it was introduced into Europe and brought to this country by the early settlers. Because of its ability to grow in a cool climate and on poor soil, it is commonly grown in our northern states. Most of the crop comes from New York and Pennsylvania. Buckwheat is used for pancake flour and as a food for cattle. The flowers are prized by bee-keepers as a source of specially flavored honey.

THE GOOSEFOOT FAMILY

The Goosefoot or Pigweed Family (*Chenopodiaceae*) includes a great many plants which have adapted themselves to marine marshes, alkali lowlands and other regions with a high percentage of salt in the soil. Such saline soil is usually inimical to plant growth. Thus many of the species are found along seashores and in desert basins. A few have become established as food plants. The members of the family have succulent stems, leaves frequently silvery-gray in color, and minute greenish flowers.

The Pigweed, or Goosefoot (*Chenopodium*), is a weed with mealy leaves, small flowers made up of a five-parted calyx. Of the sixty widely distributed species most of them are annuals or perennials; a dozen of these are common throughout the states from coast to coast. The common White Pigweed, or Lamb's Quarters, is a species which has been introduced from Europe.



CHENOPODIACEAE

Glasswort, Saltwort, Greasewood.

The Saltbush, Orach and related plants are species of *Atriplex*, characterized by scurfy gray leaves and small clusters of flowers; the staminate ones with a four- or five-parted calyx but the pistillate ones surrounded only by leaf-like bracts which remain attached to the fruit. The common eastern species of Orach is a stout spreading plant typical of salt marshes and seashores from Newfoundland to Virginia. In the Southwest and West are twenty or thirty species which are characteristic of the desert areas. They are known variously as Spearscale, Redscale, Arrowscale and Wedgescale. In the White Sands of New Mexico, the Saltbush is one of the prominent members of the strange flora which can live on the pure gypsum sands. The Desert Holly is a low gray-green shrub found on the alkaline flats of California, Utah and New Mexico. It is one of the commonest plants of the floor of Death Valley.

Glasswort (*Salicornia*) is an extremely fleshy plant with cactus-like jointed green stems and small scale-like leaves; the flowers appear at the joints. The Jointed Glasswort is common in the marshes along both our Pacific and Atlantic coasts. Other

fleshy plants of similar saline habitats include the Sea-blite (*Suaeda*), and the Salt-wort (*Salsola*) ; these are low-growing succulents not only of the coastal region but of inland flats, as well.

One of the Greasewoods (*Sarcobatus*) belongs to this family ; it is a thickly branched, spiny shrub with narrow fleshy leaves, conspicuous staminate flowers in terminal spikes while the pistillate flowers are solitary. It is a plant of desert and semi-arid regions of California, western Nevada to North Dakota and New Mexico.

The Mock Cypress (*Kochia*) is a woody member of the family. There are two native species, living in the desert basins of California, Wyoming and New Mexico. Several introduced European varieties are used as ornamental garden plants because of the compact foliage and small silky leaves.

Beets (*Beta*) are all related to a species native to the southern European coasts. The garden beet is prized for its large red root, though all the earlier varieties of the last century had white roots. In this enlarged storage root there is a high percentage of carbohydrates. When grown for the use of the leaves as a vegetable, the variety is known as Chard or Swiss Chard ; by selective breeding the leaves instead of the roots have become storehouses of food. The Mangel-Wurzel is a variety used for cattle fodder. By far the most important use of beets today is for their sugar content. The sugary character of the beet was known as long ago as 1747 ; culture began in France and Germany about 1830. It has become an important crop in the plateau states of Colorado, Utah and Montana where the late summers are cool enough to favor sugar formation in the beet roots. The sugar content of a beet averages fifteen percent, and an ordinary acre yield is ten tons of the beets. In making the sugar, the beets are topped and cut into strips which are placed in tanks filled with warm water ; there the sugar is extracted by diffusion. After various chemical treatments this sugary extract is purified of the accessory substances found in the beet. A subsequent boiling and evaporation leaves a mixture of crystalline sugar and molasses, the latter however with such a disagreeable taste that it is unfit for household use. The world supply of sugar is derived equally from beets and sugar cane.

Spinach (*Spinacia*) is a related plant whose densely crowded leaves are used as a green vegetable. Its ancestral home is southwestern Asia, where it has been under cultivation as long as there has been written history.

CHAPTER XV

The Pinks and Their Relatives



THOSE flowering plants which we have so far considered have produced inconspicuous flowers, usually green and lacking the petals and sepals which we have come to associate with typical flowers. Such catkin flowers and simple blossoms are found in the Willow, Birch, Beech, Walnut, Elm, Mulberry, Buckwheat and Goosefoot Families. As we come to the Pokeweeds, Purslanes, Four O'Clocks, Fig Marigolds and Pinks we will discover an increasingly conspicuous flower, in some cases consisting of both sepals and petals.

THE POKEWEED FAMILY

The Pokeweed Family (*Phytolaccaceae*) has many of the characters of the Goosefoot Family; the small greenish-white flowers have a calyx of sepals which resemble petals. The Pigeonberry or Poke (*Phytolacca*) has clusters of white flowers in slender spikes; it is a stout tall plant, often six feet high. In autumn the spikes are crowded with dark purple berries. Poke is found in rich damp soil from Maine to the Gulf of Mexico. This plant has the dubious distinction of being one of the few American species which have established themselves as weeds in Europe. A southern relative is the Bloodberry or Rouge Plant (*Rivina*) of the coastal plain states.

THE PURSLANE FAMILY

Several hundred species, chiefly American in distribution, make up this family (*Portulacaceae*) of small plants and succulent herbs; the flowers have both a calyx and corolla, the former of two sepals and the latter of four or five petals.

In the eastern United States the best-known member of the family is the delicately tinted Spring Beauty (*Claytonia*), named after Dr. John Clayton, an early American botanist. The small linear leaves are almost grass-like in some species, topped by small white flowers with delicate pink veins. Spring Beauty is a plant frequenting rich woods, and one of the early spring flowers. Another species is found in the West, from the mountains of California north and west to Canada and Utah.

Purslane (*Portulaca*), a European plant which has become naturalized throughout the United States, is a prostrate and spreading plant with yellow flowers. It has several relatives in the Midwest and South. In the West we find also Pussy Paws

(*Spraguea*), a plant with a basal rosette of leaves producing white or pink flowers and Bitter Root (*Lewisia*), named after Captain Meriwether Lewis of the famed Lewis and Clark expedition. Bitter Root has a basal rosette of leaves which often wither and disappear in some species before the flower stalks produce their handsome white or rosy flowers. Each flower produces a dozen or more petals, white, tinged with rose-red. Its range is from the Rocky Mountains to the Pacific coast; it is the state flower of Montana. Several species are used as rock garden plants, thriving in crevices and holes in stone walls and known for their translucent cool white blossoms. Miner's Lettuce (*Montia*) is a small plant growing in moist soil throughout the midwestern and western states. The flowering stems seem to perforate a spherical leaf, which is really two leaves united. The flowers themselves are small and white.



PHYTOLACCACEAE AND PORTULACACEAE

Poke; Purslane, Spring Beauty.

THE FOUR O'CLOCK FAMILY

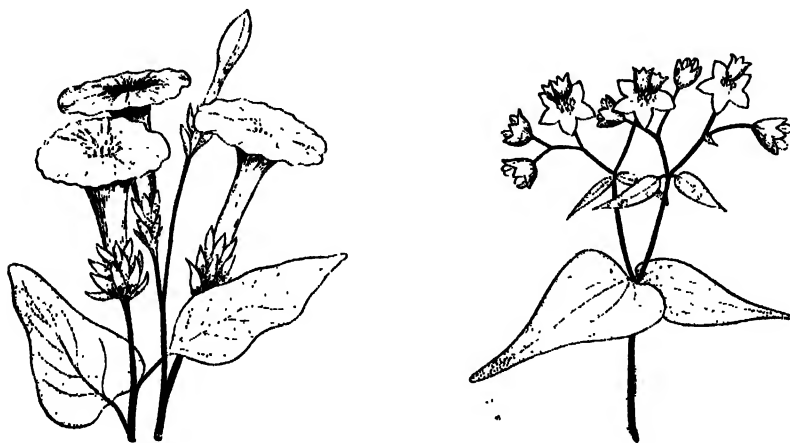
The three hundred and fifty members of this family (*Nyctaginaceae*) are best developed in southern and southwestern United States, Chile and Argentina. In the tropics they become shrubs and trees. The flowers lack petals, but the calyx is often colored so that it is mistaken for a corolla;—beneath the calyx is a leafy structure which is often trumpet-shaped, sometimes brightly colored.

The Umbrellawort, also called the Wild Four O'Clock (*Allionia*) is a small plant of dry sandy soils in our southern and western states. The white or pink flowers have a short funnel-shaped calyx. In the same geographic range we find another native genus (*Boerhaavia*) which is commonly known as Spiderling, with purple or reddish flowers.

One of the most common yet beautiful sights in spring on the California deserts is the sudden burst of color as the Sand Verbenas (*Abronia*) transform the sands into acres of lavender and purple flowers. This species is found from California to Arizona and Utah, always in dry, sandy places. Sand Verbena is a trailing plant with leaves of unequal size in pairs along the stem; the flowers have showy sepals, lobed and

spreading, grouped in flat topped clusters. Eight other species, some with white flowers, are found along the Pacific coast and east to New Mexico.

The Four O'Clock of our gardens (*Mirabilis*) was first given the scientific name of "Admirabilis", later shortened by Linnaeus. The showy flowers have no petals, but the large calyx is made up of white, red or yellow sepals fused into a tubular structure. Because the flowers open only in cloudy weather or late afternoon, they are given their common name. The garden varieties come from tropical America. Our native species include several plants of rocky and desert habitats in the arid regions of California, Arizona, Utah and Nevada.



NYCTAGINACEAE

Four O'Clock, Umbrellawort.

Bougainvillea, named after a French navigator, De Bougainville, is a South American shrub and climber which is commonly used as a porch vine and outdoor garden plant in our southern states. The flowers are small and inconspicuous, but are surrounded by showy purple or red bracts which are often mistaken for the flowers themselves.

THE FIG MARIGOLD FAMILY

This group of prostrate and low-growing plants (*Aizoaceae*) includes many species with succulent leaves which are flat and linear or angular, sometimes reduced to small scales. They are common along seashores and in dry sandy habitats. The flowers of some of the species lack petals; in others the petals are large, numerous and brightly colored.

Indian Chickweed or Carpetweed (*Mollugo*) is a matted plant bearing flowers with white or green sepals, found in waste places from Florida and Texas north to Long Island. Another low-growing plant is the Sea Purslane (*Sesuvium*), also of sandy shores from Florida to New York. It has solitary flowers in the axils of the leaves, each flower with five sepals which are tinted purple on the inner surface; there are no petals. A pink species is found in arid wastes from California to Kansas.

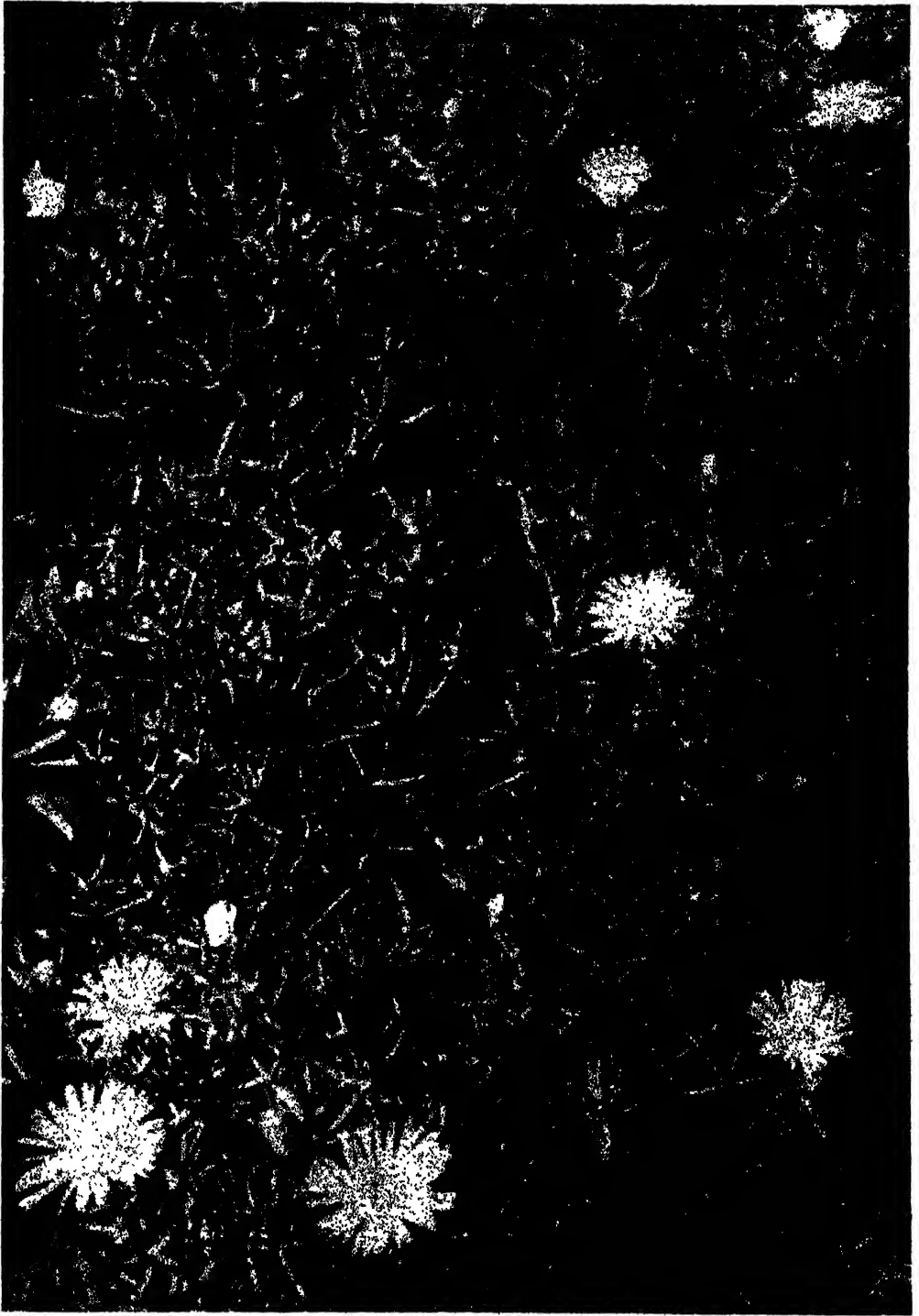


Fig Marigolds (*Tagetes*) have fleshy angular or rounded leaves and flowers which superficially resemble a Daisy; most of the species are South African. New York Botanical Garden.

The best-known genus (*Mesembryanthemum*—a long Greek name meaning “mid-day flower” in reference to its habit of opening only in the sunshine) is that containing the Sea Fig and Ice Plant. Most of the three hundred species are native to South Africa, where they are common members of the flora; other species are scattered through Australia, New Zealand, Arabia and the Mediterranean region. Our only native species is Californian. The leaves are fleshy, three-angled, or round, sometimes flattened; white, red, or yellow flowers are produced at the ends of the leafy stems.



AIZOACEAE

Carpetweed (upper left), *Mesembryanthemum Bolusii* (lower left), Sea Fig (center), *Mesembryanthemum obcordellum* (upper right), Tiger's Jaw (lower right).

The flowers have a superficial resemblance to a Composite, such as the Daisy, because of the numerous slender linear petals and the great number of stamens. The Sea Fig of the southern California sand dunes has purplish red flowers; there are several other species which have escaped from cultivation and are frequently considered wild flowers, common along the seacoast. The Ice Plant is a common cultivated species, grown for its thick foliage which has a glistening appearance due to many small glands on its surface; the flowers are small and white or reddish. There are many other species, excellent as bedding plants in dry soils and warm climates; some lack the cool looking glistening leaves but have larger, more attractive flowers. Such are the yellow-flowered Tiger's Jaw, whose thick upturned leaves are edged with long soft teeth, and the Hottentot Fig, a common border plant with upcurved fleshy triangular leaves and large yellow or purple flowers.



Pink (*Dianthus*) is a relative of the familiar Carnation, another species of the same genus. New York Botanical Garden.

THE PINK FAMILY

The Pink Family (*Caryophyllaceae*) is made up of small herbaceous plants with stems usually swollen at the nodes, bearing narrow elliptical leaves; there are some fifteen hundred species well established throughout the temperate countries. They stand midway between the *Monochlamydeae* (the families of flowering plants described in the previous chapters) and the *Dialypetalae* which will be the subject matter of the following chapters. Common wild flowers in the family include Spurrey, Pearlwort, Sandwort, Chickweed, Bouncing Bet, Catchfly, Campion and Corn Cockle;



CARYOPHYLLACEAE

Catchfly (*upper left*), Bouncing Bet (*lower left*), Sweet William (*center*), Weed Sandwort (*upper right*), Wild Pink (*lower right*).

while in our gardens are the old favorites Sweet William, Carnation, Grass Pink and numerous other Pinks.

Spurrey (*Spergula*) has narrow, pointed leaves in whorls and clusters of flowers with five sepals and five small petals. It grows among grasses in fields of New England. A European species has become naturalized in waste places throughout all our states. The Sand Spurrey (*Spergularia*) is a similar plant, but without the whorled leaves and with flowers of a purplish hue; several of the Sand Spurreys are partial to saline seacoast habitats. A Pacific coast species thrives also in rocky and sandy mountainous areas.

Pearlwort (*Sagina*) is a small, matted plant of waste ground, in moist rocky places, ranging from the northeastern states west to the prairies; two related species are native to the Pacific coast. The number of petals and sepals varies from four to five. Another low-growing plant is the common Sandwort (*Arenaria*) of which there are over a dozen species native to various states from Maine to California. Its small white flowers are made up of five sepals and five petals. The Chickweed (*Stellaria*) is a closely related genus of similar habit. The small white flowers have five sepals and five petals, the latter cleft at the tip into two lobes. The common Chickweed is a European species which has made a nuisance of itself here as a weed; other species are native in most of the states, from coast to coast.

Bouncing Bet (*Saponaria*), a larger member of the family, which is native to Europe, has become common in most of our states. The flowers have a two-lipped calyx and a corolla of five petals noticeably narrowed at the base. The mucilaginous sap forms a lather with water, which accounts for the other common name, Soapwort;—while the “sapo” of its scientific name means soap.

The Catchfly (*Silene*) has flowers unusual in that the five petals are deeply lobed to form fringed teeth or claws. In color, they may be pink or purple. Catchflies are erect plants growing in grassy places, woods and burned-over areas. Some of the introduced European species have become widespread weeds. The Wild Pink is a species with large pink petals, common in fields from Maine to Georgia. Another species is known as Bladder Campion because of the globular inflated calyx beneath the white petals; this is common in waste places of the eastern states.

The Campion (*Lychnis*), also with inflated calyx, has petals often white, sometimes pink. It has immigrated from Europe and made itself common in many waste fields and pastures in our eastern states. The Corn Cockle (*Agrostemma*) is a coarse plant with purple or magenta flowers; the inflated calyx is somewhat similar to that of the Campions. It is particularly common in grain fields throughout the country, though its native home is Europe.

The Carnation and related garden flowers are all species of *Dianthus*, so named by Theophrastus about 300 B. C.; literally the name means Jove's Flower. They are plants with large showy flowers, including at least several hundred species in temperate Europe and northern Africa. The common Carnation is native to the Mediterranean region, where it originally had flesh-colored petals; but as a result of centuries of breeding the white and red varieties are now more common. The flowers have a long tubular calyx surmounted by five broad petals which are fringed or toothed. Such wide interest was shown in the raising of various varieties that the American Carnation Society was organized in 1891 to develop new varieties and make popular the hundreds resulting from the work of Dutch, French, English, Italian and German horticulturists. The Sweet William, another species of *Dianthus*, has flowers in flat-topped clusters; each small flower has the blossom typical of the Pink with petals in white, pink or red shades. The Garden Pink is a low tufted plant which has been a favorite in old-fashioned gardens for years; its flowers are fringed and colored white, rose or purple.

CHAPTER XVI

The Buttercup and Magnolia Families



THESE two families are considered primitive representatives of the Angiosperms, since they produce flowers of a generalized rather than a highly specialized type. In the Buttercup Family the plants are all herbaceous and include many common wild flowers as well as numerous garden favorites: among them are Buttercups, Hepaticas, Anemones, Clematis, Columbine, Meadow Rue, Delphiniums and Peonies. In the Magnolia Family all of our species are woody shrubs or trees with conspicuous flowers, including—besides the ornamental Magnolias—the Cucumber Tree, Umbrella Tree, Bay and Tulip Trees.

THE BUTTERCUP FAMILY

The Buttercup Family (*Ranunculaceae*) is characterized by flowers which have their petals, sepals, stamens and pistils separate from each other; in many cases there are no petals and the sepals are like petals in appearance. Associated with the simple flower structure is a predominance of the habit of growing in swamps and wet places, which is believed by some botanists to be another indication of the primitiveness of this family. There are twelve hundred species, widely distributed throughout the north temperate regions.

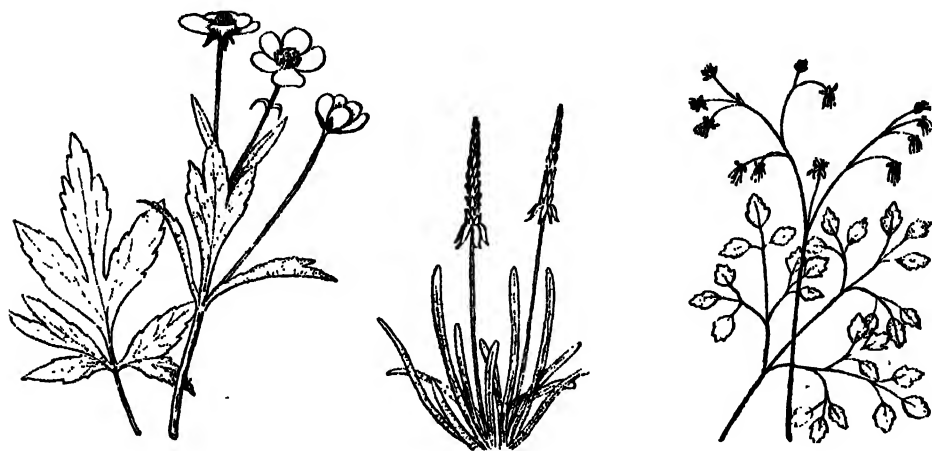
It is convenient to group the plants of this family into two groups, those with both petals and sepals, and those in which the petals are lacking. Both petals and sepals are found in the Buttercups, Mousetail, White Water Crowfoot, Goldthread, Hellebore, Columbine, Baneberry, Aconite, Larkspurs, Delphiniums and Peonies.

Buttercups (*Ranunculus*) owe their scientific name, which means "little frog", to the wet places in which they like to live. But although many of the Buttercups prefer such moist habitats, they are common flowers even in open woods, fields or roadside banks. There are few flowers better known the country over; a dozen or more species are common to every part of the United States; the genus includes over three hundred species native to the arctic and north temperate regions. Buttercup flowers usually have five sepals and five petals; the latter may be white or red in addition to the better known yellow color. The leaves are typically divided into very narrow, branching segments, with lobes in five to seven sections which have a general resemblance to birds' feet, thus the other common name of Crowfoot. Some of the Asiatic and Euro-

pean species are cultivated as garden flowers, such as the double-flowered Creeping Buttercup and the Persian Buttercup with its flowers two inches in diameter and of every color except blue.

The Mousetail (*Myosurus*) is one of the smallest plants in the family, found along shaded banks and on moist alluvial soil from coast to coast. Mousetail is so named because of the resemblance of the long fruit packed with seeds to that animal's tail. The tufts of leaves are basal and grass-like, surmounted by small greenish flowers each consisting of spurred sepals and clawed petals surrounding the elongated central axis with its pistils.

The White Water Crowfoots (*Butrachium*) are the water-dwellers of the family, being aquatic plants with creeping or floating stems, found in slow-moving streams and ponds. The submerged leaves are finely lobed into thread-like segments, a char-



RANUNCULACEAE

Marsh Buttercup, Mousetail and Meadow Rue.

acteristic of many leaves which live continually under water. The flowers have five sepals and an equal number of petals, all white.

Goldthread (*Coptis*) is also a small plant, flowering in the damp shade of the mossy woods and swamps of our northeastern and north central states. The glossy dark green leaves are divided into three wedge-shaped leaflets; the flowers are made up of five to seven small white petal-like sepals and an equal number of smaller club-shaped petals, surrounding the conspicuous stamens.

Hellebore (*Helleborus*) or Christmas Rose is a European representative of the family which has become naturalized in waste places along the Atlantic coast. It is a large plant, with greenish flowers consisting of five sepals and eight to ten smaller tubular petals.

There is little question but that one of the most beautiful of our wild flowers is the Columbine (*Aquilegia*), a uniquely American plant in that it is found in red, white and blue colors, and grows in practically every state. The brilliantly-colored flowers consist of five petal-like sepals between which the concave petals project backward in long hollow spurs. The leaves of the Columbine are compound, being divided into

many lobed and rounded leaflets. There are about thirty species found throughout the temperate zone. The common eastern Wild Columbine, inhabitant of rocky ledges in the states east of the Rocky Mountains, has scarlet flowers, golden yellow within, nodding on long frail stems. A common prairie species has blue sepals and yellowish-white petals. There are many garden varieties; the European Columbine, from Europe and Siberia, has both single and double flowers ranging in color from white to deep blue. A beautiful long-spurred variety with pale yellow flowers has come to brighten our gardens from its native home in western Texas and Mexico. Others have come from Switzerland and Japan.

The Red Baneberry (*Actaea*) is a fairly tall plant of our northeastern and central



RANUNCULACEAE

Tall Anemone, Wood Anemone and Rue Anemone.

states: the leaves are divided into sharply-toothed leaflets and the white flowers are in compact terminal rounded clusters. Each individual flower is small, with three to five sepals which fall off and leave the narrow petals and white stamens; in autumn the bright red berries are a distinctive feature of this woodland plant. The White Baneberry is a plant of similar appearance, distinguished when fruiting by white berries. The Western Baneberry has white flowers in an elongated spike like that of the White Baneberry, but the berries may be either red or white; this species is found from the Pacific coast to the Rocky Mountains. The Bugbane or Cohosh (*Cimicifuga*) is a related genus of our southeastern states, with small white flowers in long loose spikes; the sepals are deciduous, leaving the clawed petals and white stamens as the noticeable flower parts. Like all the Baneberries, it is an inhabitant of woods and thickets.

Aconite or Monkshood (*Aconitum*) has palmately lobed leaves and large showy flowers. One of the five petal-like sepals forms a helmet-shaped hood over the rest of the flower; the upper two petals are also hooded but concealed by the helmet. The flowers are blue, or more rarely, white. The Eastern Monkshood is a meadow flower



Columbine (*Aquilegia*) is one of the most beautiful of our wild flowers, found in red, white and blue colors and growing in practically every state. Hamilton, New York.

wooded hillsides from California north to Washington and east to Utah, is a coarse-stemmed plant with compound leaves and dull red flowers which bear only a slight resemblance to the large-flowered garden varieties. The flower has five or six greenish-red sepals and a similar number of reddish-brown petals. The cultivated species more closely approach the delicate range of color and fragrance of the roses than any other flower. There are many kinds of Peonies; some are herbaceous and others woody, some bear single flowers and others large double flowers; in color they range from white, yellow, orange, pink and crimson to purple. The Tree Peony of China is a shrub bearing rose-red to white flowers; it has been under cultivation in the Orient for centuries. The common garden Peonies are varieties of a single species native to Siberia, China and Japan.



RANUNCULACEAE

Scarlet Larkspur, Western Peony and Water Crowfoot.

All the preceding flowers in the Buttercup Family have had both sepals and petals, even though the former were often colored like the petals. Other species of the family lack the petals; these include Orange Root, Meadow Rue, Hepatica, Pasque Flower, Anemones, Marsh Marigold, and Clematis.

Orange Root (*Hydrastis*), or Goldenseal, is a flower of rich woods, with one American species found from New England to Kansas and Georgia, and the only other known species far away in Japan. It is a low-growing plant with a thick yellow root-stock containing substances of medicinal value. The flowers are small and greenish-white, without petals and with three short-lived petal-like sepals and a central mass of white-stalked stamens.

Meadow Rue (*Thalictrum*) is a dainty plant with pendant tassels of long stamens which are more noticeable than the other flower parts; there are no petals, and only four or five small greenish sepals. Almost a hundred species are scattered through the temperate zone, eleven of them native to the United States. In the common Early Meadow Rue the compound leaves have small rounded, lobed leaflets; it is an early



Liverleaf (*Hepatica*) has bright little blue, white or pink flowers which are eagerly sought by the nature lover abroad in the early days of spring. Hamilton, New York.

spring flower of rocky woods from Maine to Alabama and west to Missouri. In about the same range there is the Fall Meadow Rue, more commonly found in open swamps and wet meadows ; it is a more robust plant with white or purplish flowers. The Pacific coast species prefer meadows along mountain streams. One of the southern species is appropriately called Maid-of-the-Mist because of the effect produced by the many projecting delicate stamens. Among the garden species is the Feathered Columbine of Europe and northern Asia.

The Hepaticas (*Hepatica*) are known also as Liverleaf from the fancied resemblance of the three-lobed leaves to the human liver. Hepaticas are stemless, inconspicuous plants whose flowers are eagerly sought by the nature lover abroad in the first days of spring. The bright little flowers, with six to twelve sepals colored blue,



MAGNOLIACEAE

Umbrella Tree and Tulip Tree.

lavender, pink or white, push their way up through last year's dead leaves to sprinkle the open woods with gay spots of color. The common *Hepatica* lives in eastern United States, Europe and Asia ; none are found west of Missouri and Minnesota.

The Pasque Flower (*Pulsatilla*), or Wild Crocus, is a plant of the open prairies from Illinois westward to Washington and south to Texas. The low, almost stemless plants have compound leaves and erect solitary blue or white flowers with five to seven sepals.

The Anemones (*Anemone*) are literally and popularly Windflowers, the name coming from the Greek word for wind. It was from the blood of Adonis that the scarlet Oriental Anemone is supposed to have sprung. There are over eighty species restricted to the mountainous regions of the north temperate zone. Like most of the other members of the Buttercup Family, the leaves are compound and divided into numerous narrow segments. The flowers are large and showy even though there are no petals. The Tall Anemone, or Thimbleweed, is a rather large plant with stout hairy stem, bearing white flowers which grow to be an inch or more in diameter ; it is found in the woods of our northeastern states. The Canada Anemone is a smaller plant, with similar flowers, often found along roadsides and in open woods from Maine to



Marsh Marigold (*Caltha palustris*) forms bright golden-yellow spots in the marshy meadows of our eastern states. Hamilton, New York.

Maryland. Smallest and daintiest of all the Anemones is the delicate-stemmed Wood Anemone, whose solitary flowers have four to nine white or purple-tinted sepals; it prefers the solitude and privacy of the woodlands. The Western Windflower is a plant of dry mountain slopes, up to altitudes of five thousand feet. In the prairie states the Anemones have made themselves especially at home, eleven species being commonly found in meadows and along the banks of streams. The Anemones have many representatives in our gardens. There is the blue or white flowered Pasque Flower of our north central states and Siberia; the Poppy-flowered Anemone of the Mediterranean, a gay flower in all shades of red, blue and white, with blue stamens; the Broad-leaved Garden Anemone of southern Europe with red, rosy-purple, or white flowers; and the showy double varieties such as the Double Snowdrop Anemone. Closely related to the true Anemones is the Rue Anemone (*Synedemon*) of open woodlands from New England to the Mississippi valley; its compound leaves resemble Meadow Rue. The flowers are dainty and pinkish-white, grouped in terminal bunches above the leafy portion of the plant.

The Marsh Marigold or Cowslip (*Caltha*) is a coarse-leaved and stout-stemmed marsh plant obviously related to the Buttercups. The large yellow flowers have five to fifteen large sepals, and no petals. The golden yellow clusters of flowers are common sights in swampy meadows and wet woods from Maine to the Dakotas and Carolinas. •

Clematis, or Virgin's Bower (*Clematis*) is a large genus of over a hundred species of temperate zone vines and erect plants, with about twenty species native to North America; they are conspicuous for their showy flowers and the long silky projections from the pistils which form feathery tails to the fruits. The common Virgin's Bower has a three-lobed leaf and produces a great number of small flowers with three to four inconspicuous white sepals; it is a climber, covering shrubs, trees and fences with its tangled growth. It is native throughout eastern United States. The Leather Flower common to the southeastern states is another species, characterized by thick, leathery, purple sepals. The cultivated species have much larger and showier flowers than our native ones. The Japanese Clematis has flattened flowers four inches in diameter, consisting of five to six creamy white sepals, marked with purple. The showiest of the genus is the Lawson Clematis, a Chinese variety with six-inch flowers of leathery overlapping sepals, lavender-gray in color, and a center of reddish-brown stamens. Many hybrids of these Chinese and Japanese species are common as cultivated plants.

THE MAGNOLIA FAMILY

The Magnolia Family (*Magnoliaceae*) includes about a hundred species of shrubs and trees native to eastern United States, tropical Asia and Australia. They are unusual trees in that they have large showy flowers with both sepals and petals and large cone-shaped fruits.

The Magnolias (*Magnolia*) were given their name in honor of Pierre Magnol, director of the Montpellier Botanic Gardens. Some thirty species are common to North and Central America and eastern Asia; our species are southern in their distribution. The Southern Magnolia or Bull Bay is a large, handsome tree; one of the grandest of the broad-leaved evergreens, attaining a height of a hundred feet and bearing flowers often twelve inches in diameter. The large, elliptic, leathery, glossy

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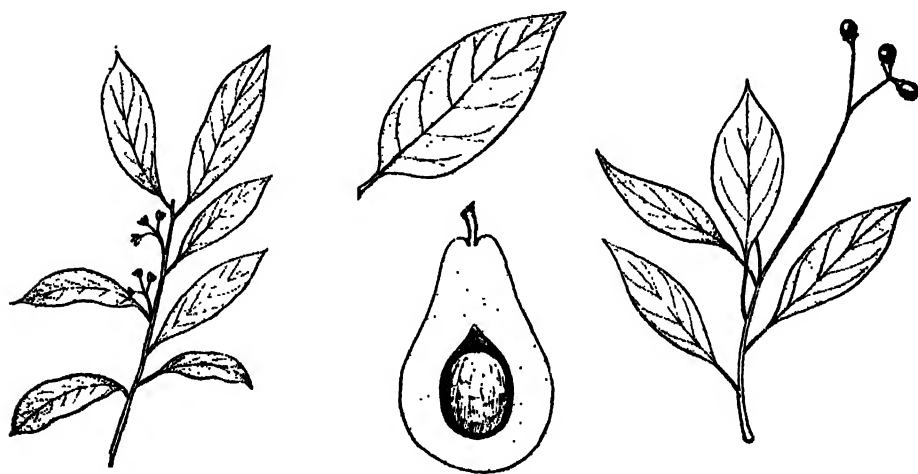
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Spice Bush (*Benzoïn*) is another strongly scented tree of shrubby habit, found in the wet woods and swamps of the eastern states. The clusters of small yellow flowers consisting of six narrow sepal segments, appear before the leaves—a characteristic which gives this tree a colorful appearance in the otherwise drab swamp vegetation of the earliest days of spring. Pond Spice (*Litsea*) is a similar shrubby tree of the coastal plain swamps, a lonely member of the genus in the United States; there are almost a hundred other species but all are restricted to tropical Asia and Australia. The flowers, with yellow sepals and no petals, appear in clusters of two or four.

The Bay Trees (*Persea*) include a hundred or more species found in the New World and in subtropical Asia. The Red Bay is a tree of the coastal plain swamps



LAURACEAE

Red Bay, Avocado and Camphor Tree.

from Virginia to Florida and Texas. Its long elliptical leaves, thick and leathery, remind one of the Magnolias. The small pale yellow flowers, with a six-lobed calyx and no corolla, grow in small clusters among the leaves. The bright red heartwood, sometimes called Florida Mahogany, is used for cabinet work and interior finish. Three other species of Bay are native to the hammocks and swamps of southern Florida.

The Avocado or Alligator Pear is a species of *Persea* which grows to be a sixty-foot tree; its native home is in Mexico and Central America, where it is one of the most prized of the cultivated fruits. The name is derived from the Spanish "aguacate" which in turn is a corruption of the original Aztec name for the fruit. It has been under cultivation in Mexico for centuries. The fruit is pear-shaped and two to six inches in diameter; a rough, green skin surrounds yellowish pulp and a large smooth stone or seed. The pulp has a nutty flavor and contains a considerable percentage of oil; its chief use is as a salad fruit. In recent years it has been increasingly cultivated in Florida and California.

Our only native true Laurel is a bushy evergreen tree of the California and Oregon canyons, known as the California Laurel (*Umbellularia*), with thick leathery leaves and greenish flowers, without petals and with six sepals. The classical Laurel

(*Laurus*) referred to by the ancients is a Mediterranean species. The common eastern Laurel belongs to another family.

The Cinnamon Tree (*Cinnamomum*) is one of fifty species of evergreen shrubs and trees of tropical Asia and Australia. The Cinnamon Tree of India and Ceylon is a small tree with stiff glossy leaves and small yellow flowers in silky clusters. The bark of the younger branches is the source of the cinnamon used as a spice. At first, under Portuguese exploitation, the forest trees were wastefully stripped of their bark. Later, after several nations had fought for control of the spice trade of the Indies, the British developed cinnamon tree gardens; since then the supply comes from such cultivated trees. Other species of the genus also yield cinnamon bark, but most of the



BERBERIDACEAE

Twin Leaf, May Apple and European Barberry.

commercial cinnamon comes from the Ceylon tree. In earlier times a Chinese species, the Cassia tree, was the source of the spice well known to the Greeks, Romans and Hebrews. Chinese use of this plant product dates to 2700 B. C.

Another useful product of the Cinnamon genus is camphor; this comes from a species native to China and Japan. The camphor is secured from processing the bark. This is also an ornamental street tree in southern California, valued because of its evergreen, shiny leaves, silvery-blue on the under surface.

THE BARBERRY FAMILY

This small family (*Berberidaceae*) of about a hundred relatively unimportant plants is of interest because of their unique distribution which demonstrates the close affinity of North American plant life with that of eastern Asia. At present the members of the family are found chiefly in the Northern Hemisphere. American species include May Apple, Umbrella Leaf, Twin Leaf, Vanilla Leaf, the Barberries and Oregon Grape.

The May Apple or Mandrake (*Podophyllum*) has a short stout stem and a large palmately lobed leaf under which is borne the solitary white flower of six short-

lived sepals and six to nine petals. May Apple is found in grassy pastures and open woods throughout eastern United States. The rootstock contains a poisonous substance. The only other species are found in eastern Asia. The Umbrella Leaf or Pixie Parasol (*Diphylleia*) is a plant of similar appearance but with the white flowers in clusters; it is native to the mountains from Virginia to Georgia. It too has its nearest relatives in the far east, in Japan.

A far more delicate plant is the white flowered Twin Leaf (*Jeffersonia*, named in honor of Thomas Jefferson); the leaves are deeply lobed to form two segments, thus suggesting the common name. The flowers are solitary and erect, with four sepals and



ANONACEAE

Pawpaw and Pond Apple.

eight petals. Twin Leaf grows in the rich, moist soil of the woods of our northeastern states; its nearest relative is another species found in Manchuria.

Vanilla Leaf, or Deer Foot (*Achlys*, named after the Greek Achlus, god of night) is a fragrant little flower of the coniferous forests of the Pacific coast; it has leaves divided into three leaflets, and flowers which lack both sepals and petals. Here again we have a case of peculiar distribution, the only other species of the genus being found in Japan.

The Barberry (*Berberis*), which gives the name to the family, is derived from the Arabic name for the fruit. The plants are bushy, with the leaves of the primary shoots reduced to sharp spines, at the base of which rosettes of small leaves appear. The common American Barberry of eastern United States has yellow flowers in drooping clusters, each flower with six sepals and six petals. Late in summer the bushes are covered with clusters of the familiar red berries. The European Barberry which has escaped to colonize waste fields of southern New England has earned an evil reputation for itself by being the alternate host plant for the destructive wheat rust. In the western states there are species known as Oregon Grape, with bluish-black berries; they are found in the gravelly moist woods. Other species grow in the river washes and arid waste lands of California. Many of the ornamental species, common as hedge plants, come from China and Japan.

THE NUTMEG FAMILY

This is a small family of evergreen trees (*Myristicaceae*) native to India, Australia and various Pacific islands. The small flowers have a three-lobed calyx but no petals, and produce a fleshy one-seeded fruit. The fibrous outer coating of the seed is known as mace, and the convoluted seed itself is the nutmeg of commerce. Nutmeg trees (*Myristica*) grow only in the hot moist valleys of the tropics; they thrive in the Molucca Islands, in the West Indies and Jamaica, where most of the commercial nutmeg is grown. Nutmeg and mace were unknown to the Greeks and Romans, apparently first coming into use as spices in Constantinople about 500 A.D. Today over five million pounds of nutmegs are imported annually into the United States alone.

THE PAWPAP FAMILY

The Pawpaw or Custard Apple Family (*Anonaceae*) includes shrubs and trees with five hundred, mainly tropical, species. The American species extend from the tropical tip of Florida north along the coast to New Jersey, west to Texas and Nebraska. The flowers, solitary in the axils of the leaves or in small clusters, consist of three sepals and a large calyx of six to twelve petals colored white, yellow, pink or purplish-green.

The Pawpaw (*Asimina*) is the most northern representative of the family, found in rich moist soil as far north as New Jersey; it is a low deciduous tree with narrowly elliptical leaves, purplish-green flowers and cylindric fruits four to six inches long which are sometimes called False Bananas and sold in the markets in the regions where the tree grows naturally.

The Pond Apple or Custard Apple (*Anona*) trees have pungently aromatic leaves which are thick and leathery; it is a tropical genus, with only a few species venturing into the southern tip of Florida. The white or yellow flowers produce an aggregate fruit which is the same length as the Pawpaw but more rounded in shape and less edible. It is a tree of pond margins and swamps, and is especially common along the streams flowing from the Everglades.

The Poppy Family and Its Relatives



THE Poppy and Fumitory Families include some of our most beautiful wild flowers ; there are few species of economic importance except the Opium Poppy. Yet because of the attractiveness of their blooms, it is worth while becoming familiar with some members of each fa



PAPAVERACEAE

Cream-cups, Tree Poppy and Celandine.

THE POPPY FAMILY

The Poppy Family (*Papaveraceae*) is made up of about four hundred species of herbs and a few shrubs, characterized by a milky or colored sap and showy flowers. Members of the family occur widely scattered in various parts of the world. There are such familiar wild flowers in the group as Bloodroot, Celandine, Cream-cups, Matilija Poppy, Tree Poppy, Celandine Poppy, Prickly Poppy, California Poppy and the many True Poppies. Numerous varieties of the latter are popular garden flowers, one produces the opium and morphine of medicinal value.

Bloodroot (*Sanguinaria*) appears in early spring throughout most of the states east of the Mississippi River, growing in the rich moist soil of open woods. Sparring

its way upward through last winter's debris, the large palmately lobed leaf first appears tightly rolled, sheathing the flowering stalk and its single white blossom. Each flower has two sepals and eight to twelve narrow petals. The rootstocks are filled with an orange-red juice, which is responsible for both the popular and scientific names. Another flower with orange-red roots is the Celandine Poppy (*Stylophorum*) which may be found in damp woods from Pennsylvania to Missouri, its flower also has two sepals but the four broad petals are either red or yellow in color.

Celandine (*Chelidonium*) is one of the many plants, like catnip and hoarhound,

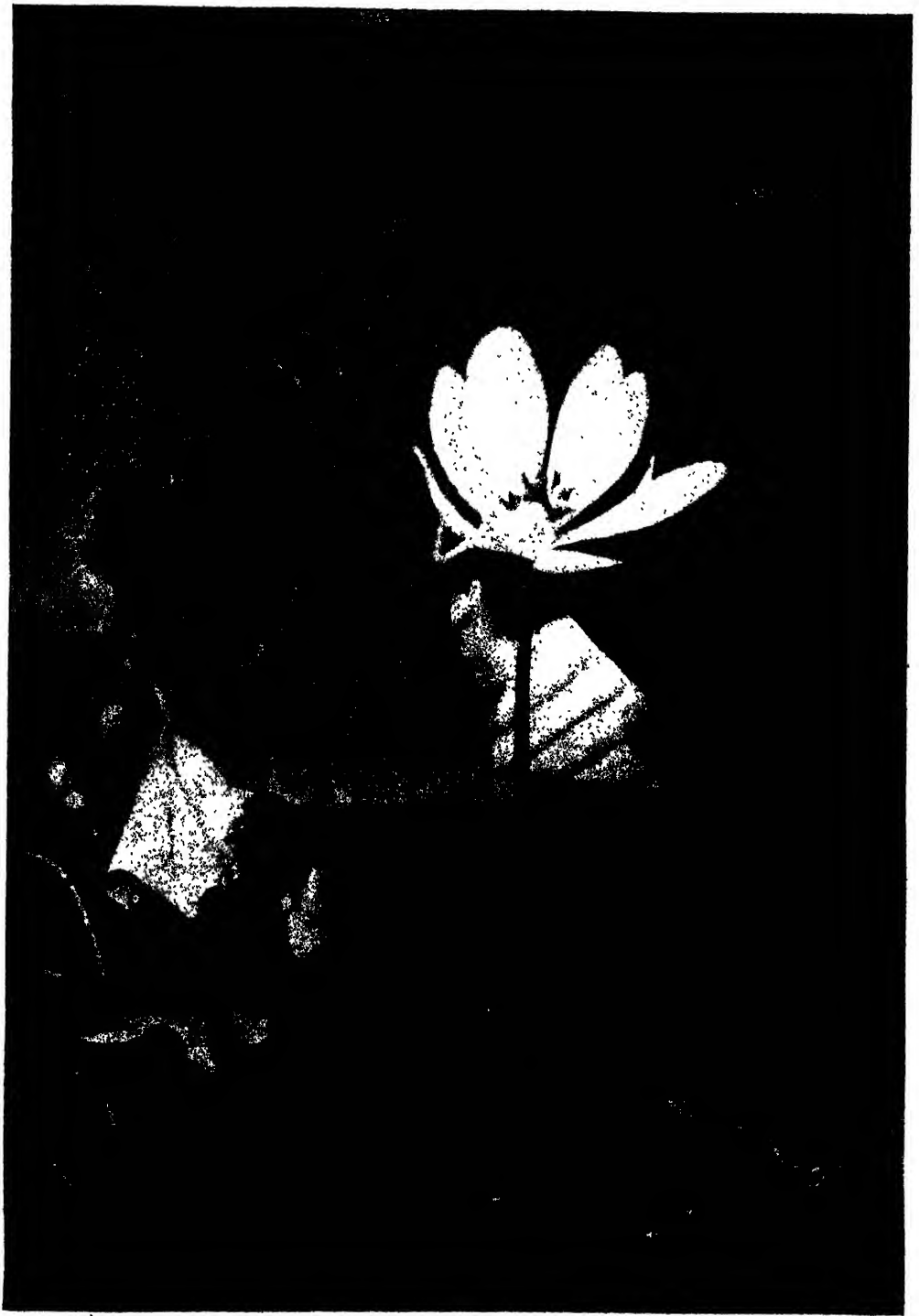


PAPAVRACEAE

Carolina Poppy, Opium Poppy, Corn Poppy and Iceland Poppy (extreme right)

which, brought to this country by the early settlers, has escaped to become a common wild flower. Celandine, originally from Europe, is now frequently found as a common weed about ruined farmhouses and old stone walls. The plants have stout brittle stems, which contain a light yellow sap, and compound leaves divided into toothed lobes. The bright yellow flowers occur in clusters, each individual flower consisting of two sepals and four yellow petals.

The Prickly Poppies (*Argemone*) are characterized by prickly stems, an orange-colored sap, and leaves which are often edged with sharp teeth. The Mexican Prickly Poppy is a yellow flower which has become naturalized on hillsides and cultivated ground along the Gulf states and through the Southwest, its flowers have pointed bristly sepals beneath four to six petals. In the southern coastal plain region there is the white Carolina Poppy, while another white flowered species is the common



Bloodroot (*Sanguinaria canadensis*) has a large palmately lobed leaf which often surrounds protectively the single white blossom with its narrow petals and golden stamens. Hamilton, New York.

Prairie Prickly Poppy. The Western Prickly Poppy or Chicalote has white petals and horn-like projections to the sepals; it is found in mountain valleys and canyons from California east to Texas.

Cream-cups (*Platystemon*) is a small western plant with linear leaves, weak hairy-white stems and white or yellowish flowers whose six petals form an erect cup-shaped bloom. It is common in open ground on the California foothills.

Two of our western members of the Poppy Family are tall, bushy plants. The Ma-



FUMARIACEAE

Allegheny Vine (*upper left*), Dutchman's Breeches (*lower left*), Wild Fumitory (*upper right*), Pale Corydalis (*lower right*).

tilija Poppy (*Romneya*) is often eight feet high, the stems bearing compound leaves and large white short-stemmed flowers. Each flower consists of three sepals and six broad frilled petals—the resulting blossom four or five inches in diameter. This handsome member of the family grows in gravelly stream washes at low altitudes in the California hills and is one of the striking sights when the spring flowers begin to carpet the hillsides with color. The Tree Poppy (*Dendromecon*—a Greek name compounded from the words for tree and poppy) becomes a bushy plant four to eight feet high, common on dry slopes and ridges of the lower foothills of California. The Tree Poppy has distinctive yellow-green entire leaves and golden-yellow flowers borne on fairly long stems; each flower has the usual two sepals and four large petals.



The Prickly Poppy (*Argemone*) is a showy flowered western member of the Poppy Family with prickly stems. Hemet, California.

Perhaps the best known western wild flower is the California Poppy (*Eschscholtzia*) of which there are five related species growing on the grassy hillsides and more arid desert slopes from California east to Arizona and Utah. It is a low-growing plant with pale compound leaves and bright orange-yellow flowers; the two sepals are united into a pointed cap which is pushed off by the four expanding petals. There are few sights so colorful as a treeless expanse of rolling hills aflame with millions of these golden flowers, crowding each other so closely that no earth or foliage is visible.

The True Poppies (*Papaver*) include at least a hundred species most of which are native to the Mediterranean region; one species is found in the Southern Hemisphere, two in California. All have large silky bright colored petals surrounding a center of numerous stamens. The California True Poppies, common to grassy hillsides, have slightly drooping flowers with two sepals and four red petals. Poppies, because of their large showy blossoms in a great range of colors, have long been popular as garden flowers. There are many varieties, derived from four basic species—the perennial Iceland and Oriental Poppies and the annual Corn and Opium Poppies. The Iceland Poppy is a robust and nearly stemless plant with a cluster of basal compound leaves from which several leafless flowering stalks produce the orange, red, yellow or white flowers; it is a hardy plant found over a vast expanse of the arctic regions, where it is one of the commonest yet most colorful wild flowers. The Oriental Poppy, native to the Mediterranean region and Persia, has the largest flowers of all the poppies, often six inches in diameter. Oriental Poppies are stiff and hairy-stemmed with six petaled flowers of bright scarlet hue, marked with black at the base of each petal. New varieties have appeared as a result of experimental breeding, giving a greater color range of red, orange, salmon and pink tints. The Corn Poppy of Europe, made famous in the poem of "Flanders Field", has hairy and finely lobed leaves and small flowers of red, scarlet, purple or white. The fourth common garden poppy is the Opium Poppy of Greece and the Orient; it is a strong-stemmed, tall stately plant with grayish-green foliage and white, pink or red flowers.

Opium and its derived products come from the Opium Poppy. The narcotic character of the juice of this plant was known to the Greeks in 300 B.C. The wild plant is native to the north coast of the Mediterranean but has become common in cultivation in Egypt, India, Asia Minor and Persia; most of the medicinal supply comes from Turkey. Opium is secured by slitting open the unripe fruit capsules and allowing the milky juice to flow out; this is collected by hand, being smeared on a poppy leaf as the laborer moves from plant to plant. When a sufficient quantity of the juice is collected on a leaf, it is allowed to dry in the shade. This dried capsule juice is the commercial opium. Chemically opium is a complex substance made up of many different alkaloids which act as drugs; the most important is morphine. Strangely enough, the poppy seeds themselves have no injurious effect upon the body, and are frequently eaten, sprinkled on buns and cookies. Opium as a drug is eaten or chewed in Persia and India; it was introduced into China in the seventeenth century and there the habit of smoking it began. Since then the use of this drug has spread so rapidly that it is estimated about one quarter of all Chinese men now smoke opium. In moderation it seems to have no more injurious effect upon the body than alcohol, and the human system can adjust itself gradually to amounts which at first would be fatal doses. But like



The California Poppy (*Eschscholtzia californica*) is one of the best known western wild flowers, often coloring acres of hillsides with golden yellow. Claremont, California.

many other plant products, this has become a problem in world traffic and control, as well as a useful medicinal drug.

THE FUMITORY FAMILY

The Fumitory Family (*Fumariaceae*) is a relatively unimportant family of small, often stemless, plants with fern-like compound leaves and odd-shaped flowers. Each flower has small, scale-like sepals and four conspicuous petals in two whorls, the one pair of petals projecting as spurs while the other pair forms a hood over the pistil. The pods and seeds are like those of the poppies. The family includes Allegheny Vine, Dutchman's Breeches, wild and cultivated Bleeding Hearts, *Corydalis* and Fumitory.

Allegheny Vine or Mountain Fringe (*Adlumia*) is a climbing plant found scrambling over shrubs and trees in the eastern and central states. It bears clusters of flowers opposite the compound leaves. Each flower has four white or pink petals which are united into a tube.

Dutchman's Breeches (*Dicentra*) is an unusual little flower, also of the eastern and central states; the scientific name is compounded from two Greek words meaning two spurred, in reference to the two projecting petals which form the "breeches". This flower is an inhabitant of rich woods where its stemless compact mass of fern-like leaves often hides the flowering stalks with their pendant white and yellow flowers. The Western Bleeding Heart is a Pacific coast species, found in shady woods, with flowering stems a foot or more in height bearing rose-purple flowers with partially fused petals. Squirrel Corn is a northeastern species extending west to Kansas, so named because of the little tubers which resemble grains of corn. The heart shaped corolla of each flower is white, tipped with rose. The Bleeding Heart of our gardens is a species coming originally from Japan and introduced to England in the middle of the last century. The deep pink flowers have a heart-shaped corolla with white inner petals.

Corydalis (*Corydalis*) is the Greek name for the crested lark and is appropriately applied to this dainty flower with the single spur of the corolla twisted to form a crest above the rest of the flower. The Pale *Corydalis*, dweller on the rocky ledges of our eastern and central woodlands, is a delicate plant with branching stems bearing flowers which are rose-colored and tipped with yellow. The Golden *Corydalis* of the western as well as the eastern states has orange-yellow flowers.

Wild Fumitory (*Fumaria*) is an escaped European plant now found commonly in waste places from New England and Florida west to the Rocky Mountains. It is a low growing plant with the compound leaves typical of the family, bearing purplish flowers in clusters. Like the *Corydalis*, only one of the outer petals is spurred.

CHAPTER XIX

The Mustard Family



THERE are many plants which are designated as "weeds"—a term of opprobrium applied vaguely to any annoying plant which insists upon growing where other plants are desired. Weeds are the persecuted members of the plant world; and like any persecuted race, they develop unusual powers of adaptation and survival. Many



CRUCIFERÆ

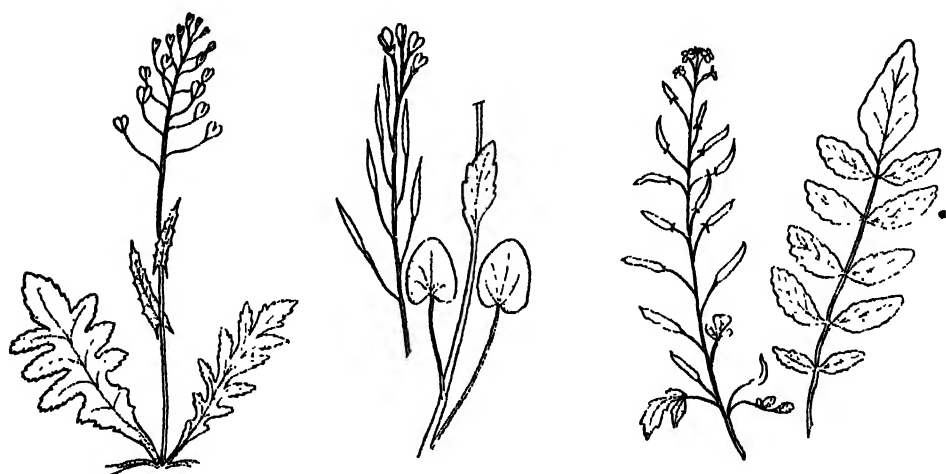
Pepper Grass, Penny Cress and Bladder Pod.

plants, when introduced into a foreign country where there are none of the natural enemies to keep them in check, may run wild and crowd out native or garden plants. Then they are considered weeds. It comes as a surprise to find that many of these so-called weeds are really attractive plants with beautiful flowers.

The Mustard Family (*Cruciferae*) includes, perhaps, as high a percentage of weed plants as any other family excepting the grasses. It includes almost two thousand species of herbaceous plants of Europe, Asia and North America; many of them weeds, a few garden flowers, and some food plants. The wild flower species are such plants as Pepperwort, Penny Cress, Bladder Pod, Shepherd's Purse, Rock Cress, Water Cress, Bitter Cress, Toothwort, Crinkleroot, the Rockets, the Mustards and Wild Cabbage. The garden varieties are the well-known Sweet Alyssum, Candytuft,

Stock and Wallflower. Among the many edible plants in the Mustard Family we find Cabbage, Cauliflower, Kale, Brussels Sprouts, Mustard, Turnip, Radish, and Horseradish. The various species are often more conspicuous because of their odd-shaped pods than for their unexciting flowers. The flower, however, is quite characteristic of the family, consisting of four petals, narrowed at the base, arranged in the form of a cross, alternate with the sepals. This arrangement of the petals in a cross explains the scientific name of the family, which means "cross-bearer". The flowers are usually borne in loose open clusters.

Pepper Grass or Pepperwort (*Lepidium*) is a weed of roadsides and waste places with entire or compound leaves and clusters of small white, red or yellow flowers; the fruit is a flattened and winged pod. Garden Cress, a related species introduced



CRUCIFERAE

Shepherd's Purse, Bitter Cress and Water Cress.

from Europe and cultivated as a salad plant, has escaped and sometimes is found growing wild. The Desert Alyssum is a species of the southwestern deserts.

Penny Cress or Wild Sweet Alyssum (*Thlaspi*) is another European plant which has become naturalized, especially in our northern states. It has undivided and often clasping leaves, and small white or purplish flowers in terminal bunches.

Bladder Pod (*Lesquerella*) is a hairy, low-growing member of the family most of whose leaves are basal and whose flowers are usually yellow. The plant is easily recognized when fruiting by its inflated bladder-like seed pods. The western species are plants of the mountains and deserts, the midwestern ones of dry plains and stony hillsides.

Shepherd's Purse (*Capsella*) is a slender little plant known to all school children because of the peculiar triangular pods; the scientific name comes from the Latin, meaning "little box". The flowers are small and white, borne in clusters. Introduced from Europe, it has become a common roadside and garden weed.

Rock Cress or Wild Candytuft (*Arabis*) is a large genus of small flowered plants,

many of which are considered weeds. The flowers, in terminal or axillary clusters, have petals which are usually white, though yellow, pink and purple varieties occur. The Rock Cresses are especially abundant in the prairie region, where seventeen species are found. The western species thrive on stony mountain slopes and in rocky canyons; some of them are prized as rock garden and alpine plants. The pods are elongated and flattened, sometimes sickle-shaped as in the species known as Sickle Pod.

The Bitter Cress or Bulbous Cress (*Cardamine*) is one of the aquatically inclined members of the Mustard Family, growing in wet woods and meadows; the stout stems bear entire or compound leaves and fairly large flowers which are white or purple in color. In autumn they produce elongated pods which spring open to disperse



CRUCIFERÆ

Sea Rocket, Radish and Sickle Pod.

the seeds. The edible Water Cress (*Rorippa*) is an aquatic plant with floating or creeping stems and fleshy leaves; it is a native of Europe and Asia, but is frequently found growing wild in slow streams and springs.

Sea Rocket (*Cakile*) is the seashore representative of the family. It is a bushy succulent plant found along both the Atlantic and Pacific seacoasts and along the shores of the Great Lakes. The fleshy stems bear lobed leaves, purplish or white clustered flowers, and short two-jointed pods. The Prairie Rocket (*Cheirinia*) of the dry plains and hills of the midwestern states bears large yellow or brown flowers in terminal clusters.

Two of the attractive wild flowers in the Mustard Family are Toothwort and Crinkleroot, both species of the same genus (*Dentaria*). Toothwort has compound leaves, each divided into narrow toothed segments, and a small terminal cluster of white (sometimes purplish) flowers which are large compared with the flowers of most of the Mustards. Toothwort is common in the moist woods from the Atlantic coast to Minnesota. Crinkleroot has fewer flowers, usually white or pink, and borne

at the tip of a stem which projects beyond the pair of three-lobed leaves, its range is about that of the Toothwort.

The Hedge Mustards (*Sisymbrium*) include some European species which have become noxious weeds, they grow in bushy clumps and have small yellow flowers. One species of the arid plains breaks loose and is tumbled along by the wind until it finds a resting place where soon new Mustard plants appear. Such Tumble-weeds, of this and other species, are common sights along the open stretches of the southwest and midwest, where the closely branched masses collect against fences and railroad embankments. Wild Mustard or Charlock (*Raphanus*) is a common weed naturalized from Europe, with familiar white or yellow flowers, it is considered one of the worst weeds in the grainfields of the midwest.



CRUCIFERAE

Sweet Alyssum, Stock and Candytuft

Wild Cabbage (*Caulanthus*) includes a dozen species with clasping stem leaves and white, purple, or yellow flowers, often with crisped petals. They grow on dry slopes and stony land in the western states from California to Arizona and Utah. One species known as Desert Candle, produces stout, hollow, yellowish stems, tipped with flowers consisting of purple sepals and white petals.

Garden flowers of the Mustard Family are few. Sweet Alyssum (*Alyssum*) is a low, densely flowered plant native to Europe and the Mediterranean region, popular as a rock garden plant. The linear leaves are pointed and often gray-green in color, there is an abundance of small white flowers in heads or bunches. Each flower is white or yellowish, delicately honey scented. In many states Alyssum has escaped and become a wild flower thriving in stony and dry habitats spurned by most native plants. Stock or Gilliflower (*Matthiola*) has many species native to the Old World and Australia, all being herbaceous plants with stiff hairy stems and flowers collected in a dense terminal mass. The flowers are purple or white, and sweetly scented. Wall-flower (*Cheiranthus*) has several species native to western North America found in

B.C. ; Radishes were grown at the time of Christ ; and even Parsnips and Horseradish have been grown as food plants for some thousand years.

Other species of *Brassica* are known as Turnip and Mustard. Turnip plants develop a fleshy root, packed with stored food ; the color of the flesh is usually white or pale yellow. Its origin is uncertain, but it most likely was a native of Europe or western Asia. Black Mustard, a native of Europe and Asia, is a tall plant with yellow flowers ; the brown seeds are ground up in making the common table mustard. The leafy parts are sometimes used as a garnish or salad green. A related species has established itself as a common wild flower, the masses of yellow flowers being common sights in many states. In the Southwest the Wild Mustard is sowed over burned mountainous areas to help keep the soil in place.

The Radish (*Raphanus*) is found in the temperate regions of the Old World. Introduced as a garden vegetable by early Americans, it has become natualized as a wayside weed, often with surprisingly attractive white or purple flowers and a beaked pod for fruit. It is one of the few European plants to have become introduced into Chinese and Japanese gardens. There are many edible varieties, varying from turnip-shaped roots to long slender ones, and in various colors from white to red.

Horseradish (*Armoracia*) is another European genus which has become an American garden vegetable. The white fleshy root is grated, sometimes mixed with vinegar, and used as a condiment.

Carnivorous Plants

IT IS a well-known journalistic aphorism that when a dog bites a man, no one is particularly interested, but when a man bites a dog—that is news. After the same line of reasoning, when an animal eats a plant it is merely the usual arrangement in nature, but when a plant catches and devours an animal, that is a newsworthy reversal of affairs.

We have seen that green plants are able to manufacture their organic food requirements out of sunlight, air, water and a few minerals. There are some five hundred different kinds of plants which, though green and perfectly capable of manufacturing their own food, have fashioned their leaves into unique traps for the capture of insects and other small animals. More remarkable still, some of these carnivorous plants have glands which secrete a digestive juice so that the animal remains are actually digested and absorbed in much the same manner as in the human digestive tract. This fantastic ability of certain plants to catch and devour animals has led to many lurid stories of the dangerous man-eating plants (usually purported to be in some out-of-the-way tropical jungle) which catch hold of the feet of unwary travellers, hold them fast until they die of starvation, and then feed upon their carcasses. Unfortunately for these entertaining stories, all the carnivorous plants are small—and the largest animals caught in their traps are dragonflies or small frogs. More frequently the victims are ants, beetles, flies, gnats, worms, various crustaceans and larvae.

Most of the carnivorous plants are found in five families of Dicot Angiosperms. The Bladderwort Family includes common aquatic and amphibious plants such as the Bladderwort and Butterwort. There are three different families of Pitcher Plants. One family includes the common Pitcher Plants of the swamps and bogs of eastern United States, California and Guiana. Another family includes a single species of Pitcher Plants found in the Australian Bogs. And in the tropics there is a family of climbing Pitcher Plants with elaborate and brightly-colored pitchers for catching animal food. The most highly developed of all the carnivorous plants are found in the Sun Dew Family, among whose members we find many with clever devices for trapping small organisms; most remarkable of these is the Venus Fly Trap. This family is widely distributed through the United States, Australia, Europe, Asia and Africa.

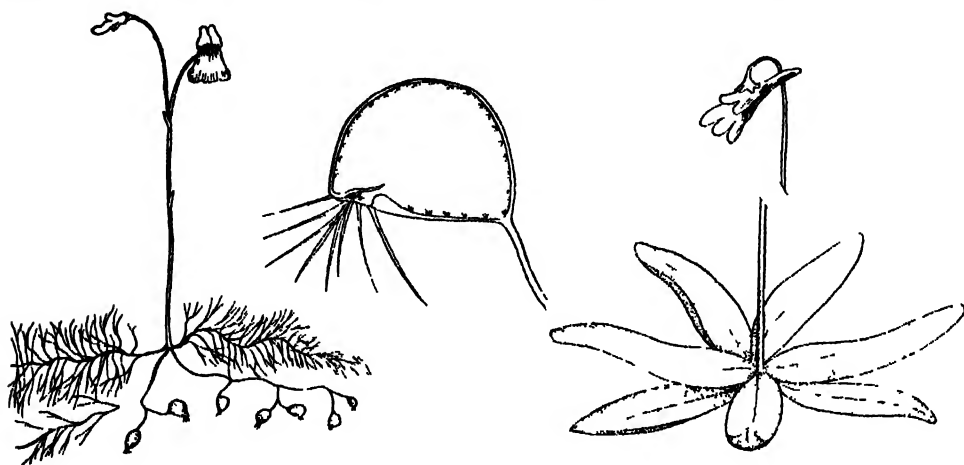
THE BLADDERWORT FAMILY

The Bladderwort Family (*Lentibulariaceae*) is a small one of only two genera of aquatic and terrestrial plants. The Bladderwort (*Utricularia*) is a plant with submerged, floating leaves and stems. The leaves are finely divided into fern-like segments which gives a delicate appearance to the compact masses of foliage on their long sinuous stems. In addition to the ordinary green leaves there are a number of small spherical bladders which act as the animal traps. The bright yellow flowers are borne on tall slender stems which rise above the water; each flower has a two-lobed calyx and a two-lipped corolla. Bladderworts live in the shallow water of roadside pools, small ponds and swamps—wherever there is an abundance of minute larvae, crustaceans, small worms and protozoa. Each of the pale green bladders of the Bladderwort is flattened on the bottom, where there is a small opening surrounded by a mass of stiff bristles. Closing the opening from the inside is a delicate trap door, a flap of tissue hinged on the inside and closing against the doorway. A small larva, pursued by a minnow, frantically rushing for a place of safety, can swim freely through the bristles around the opening into the bladder, while the same bristles repel the larger animal. Pushing against the trap door, perhaps by chance, the larva gets inside of the bladder; once there he finds himself in a death chamber already containing other small animals similarly trapped. When they push against the door from the inside, it can not open. Eventually the larva and its neighbors die and their bodies decompose to form a nitrogenous food for the plant. Lining the cavity are a great number of special digestive cells which absorb the animal food and pass it along through the plant tissues for their use. That such a perfect mechanical trap should be developed from ordinary foliage parts of a plant is one of the marvels of plant evolution.

The Butterwort (*Pinguicula*) has a basal rosette of long narrow leaves from the center of which erect stalks grow up to be capped by yellow, purple or violet flowers with a five-lobed calyx and a spurred corolla. Butterworts grow on moist soil in the pinelands and shallow water pools from Vermont to the coastal plain (where they are most common) and west to Minnesota; they are more terrestrial plants than the Bladderworts. The slender tapering leaves are in the form of a basal rosette, each leaf slightly hollowed like a trough with the surface covered by a great number of hair-like stalked glands. The top of each gland is moist with a sticky substance which is fatal to any small insect which alights upon the leaf. The contact of the insect's body stimulates the glands to secrete an extra amount of the mucilaginous material and as the insect struggles it becomes the more permanently trapped on this living fly paper. Sometimes the leaf margin curls over the victim, thus aiding in his capture. When the insect dies its body is acted upon by an acid digestive juice secreted by other leaf glands; and after a process very much like animal digestion the soluble nitrogenous material is absorbed by the leaf. Not only animals, but such plant substances as pollen grains and bits of vegetation are digested if they become entangled with the sticky hairs. The digestive action of the Butterwort leaf has been used for centuries by Laplanders in making a junket-like food out of milk which is poured over the leaves.

THE PITCHER PLANTS

The various families of Pitcher Plants are characterized by hollow, tubular leaves which look like pitchers, urns or goblets. The common American family (*Sarraceniaceae*) includes both eastern and western species. The eastern Pitcher Plant (*Sarracenia*)—also called Frog Bonnet and Bog Bugle—has a basal rosette of ‘pitchers’ which form compact clumps among the mosses of bogs and swamps, each ‘pitcher’ has a wing-like ridge running lengthwise and a flaring mouth, the whole being a mottled green and brownish-purple with red veins. The flowers are purple-red with five sepals and five petals, the expanded top of the pistil forming a conspicuous shield or cap over the center of the flower. The corresponding Pacific coast species (*Darlingtonia*) is a plant of similar appearance, but slightly more slender and with a hood over the top of the ‘pitcher’. Each of the colorful pitcher-like leaves is in re-

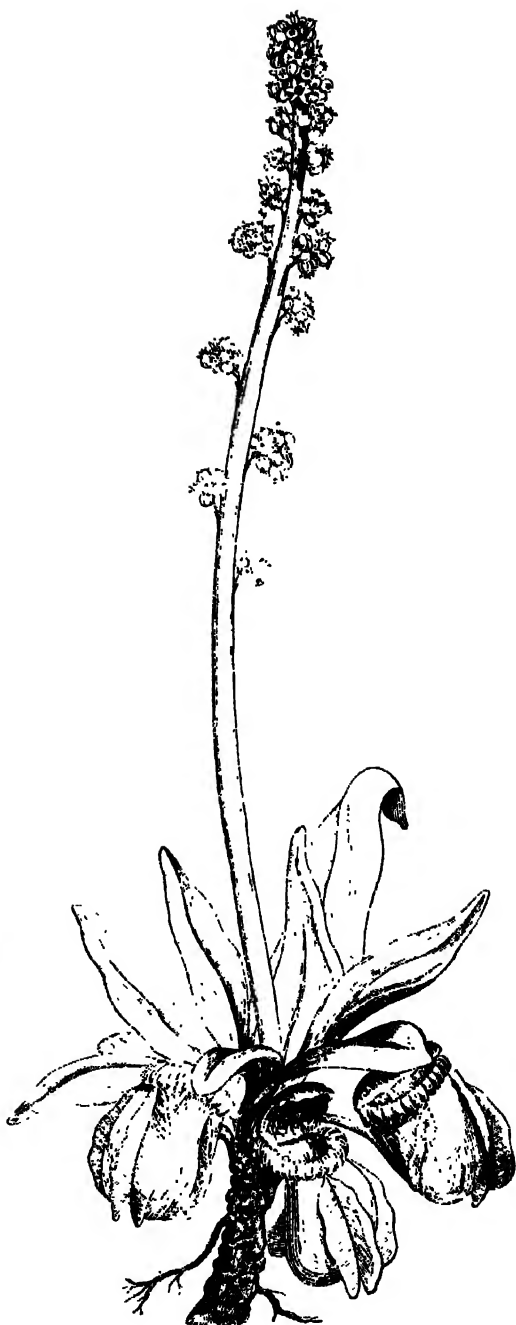
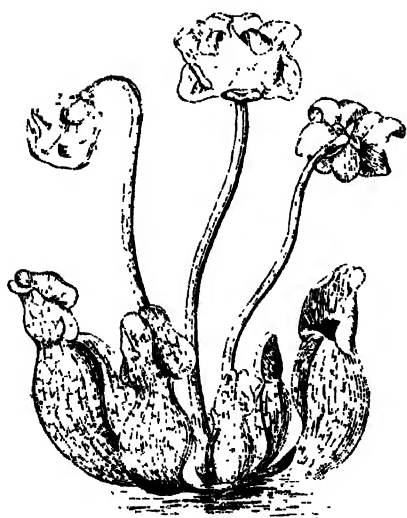


TENTACULAR PLANTS

Bladderwort—entire plant (left) and diagram of a single animal-trapping bladder,
Butterwort, showing basal rosette of leaves and flower

ality a death trap for small insects. About the mouth of the pitcher special cells secrete a honey-like nectar which attracts crawling and flying insects. Ants crawl up the outside of the pitcher, looking for the nectar; once at the lip of the pitcher, they keep on climbing down the inside. But their descent is more rapid than expected, for the inside is lined with close rows of sharp spines which point downwards and make a slippery surface; the ants find themselves suddenly in a pool of liquid—chiefly rain-water—which accumulates in the bottom of the pitchers. When they struggle to climb out, the downward pointing spines make escape practically impossible. After they drown, the insects are exposed to the action of bacteria found in the water; the decomposed remains are absorbed by the cells lining the pitcher wall.

The tropical Pitcher Plants (*Nepenthaceae*) are all species of a single genus (*Nepenthes*). When young, the plants look like ordinary Pitcher Plants with a basal rosette of tubular leaves. But later growth gives rise to a sturdy vine which climbs over the shrubs and trees of the jungle. From this climbing stem there develop leaves each one showing a remarkable division of labor within itself. Each leaf consists of

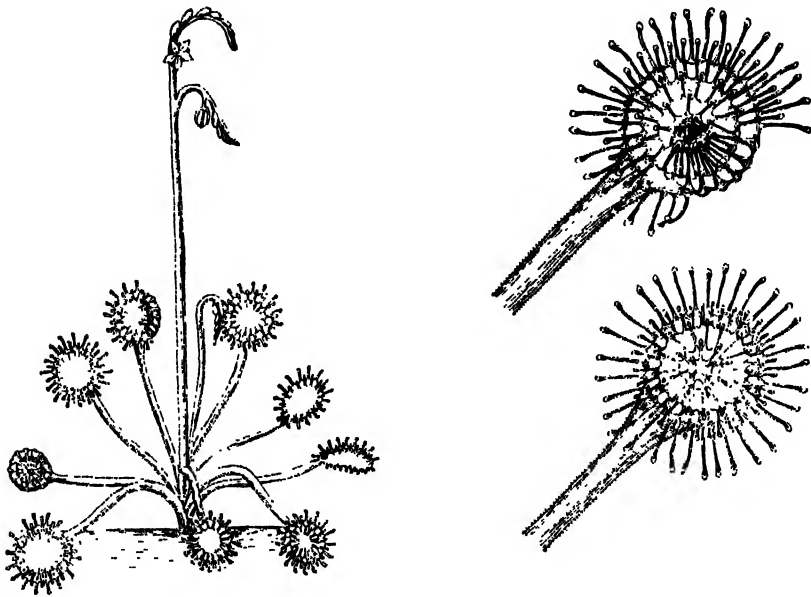


R.M. BLANCHARD

NEPENTHIACEAE, SARRACENIACEAE AND CEPHALOTACEAE

Tropical Pitcher Plant (*upper left*); Common Pitcher Plant (*lower left*); Australian Pitcher Plant (*right*). Drawing by R. M. Blanchard.

three parts: first there is a flattened and expanded blade which is green and functions as a normal leaf; the tip of this forms a graceful pendant pitcher as brilliantly colored as a tropical flower in various shades of yellow, green, purple or blue while the margin is often blood red and the interior of the pitcher a light blue; beyond the pitcher the leaf continues as a coiled tendril which winds itself around the branches of other plants. At a distance the pitchers give the impression of flowers. As an added lure for insects, they often produce a honey-like substance in such quantities around the rim of the pitcher that this part of the plant drips and glitters with the sugary juice which is a bait for the unsuspecting victim. Flying or crawling in-



DROSERACEAE

Sun Dew, general habit and leaf with glandular hairs closing over insect (*upper right*), unstimulated leaf (*lower right*). Drawing by R. M. Blanchard.

sects, venturing beyond the rim of the pitcher, find within a waxy surface down which they slide into a pool of liquid secreted by the glandular cells of the leaf; climbing back up the slippery steep walls is impossible, and flying insects find the rim armed with curved downward pointing teeth which check their flight. After the insect has drowned, the body is speedily acted upon by the acid digestive juice in the water, and the nitrogenous food absorbed by the cells lining the cavity.

The Pitcher Plant family of Australia (*Cephalotaceae*) also includes but a single genus (*Cephalotus*). There are two kinds of leaves in the basal rosette so typical of these carnivorous plants; the upper leaves are ordinary foliage leaves, while the lower ones are modified to form stout pitchers rimmed with teeth and covered by a lid which is brightly colored like a flower. Ants are particularly common victims in the pools within these pitchers.

THE SUN DEW FAMILY

The Sun Dew Family (*Droseraceae*) includes eighty species, of which the most common forms are the Sun Dew, the Flycatcher and the Venus Fly Trap. The Sun Dew (*Drosera*) is a small plant with a basal rosette of circular flattened leaves which generally lie flat on the ground. The leaves have a glistening red appearance because of the many red-stalked hairs on the surface, each hair in reality a gland tipped with a drop of secreted mucilage. The glistening effect gives the impression of a dew-covered plant, explaining the common name as well as the scientific one—which is



DROSERACEAE

Venus Fly Trap and Flycatcher.

the Greek term for "dew". Sun Dews occur on damp, mossy ground in practically all of our states. Small pink or white flowers are borne in a terminal cluster on long stamens arising from the center of the basal mass of leaves. Each flower has four to eight sepals and the same number of petals. Each circular leaf, about the size of a small coin, looks like a little pincushion as it lies innocently enough amid the towering grasses which surround it. A gnat or a fly, alighting in the hope of getting some sweet nectar, finds its feet stuck fast to the glandular hairs; the more the insect struggles, the more the glands are stimulated to secrete the mucilage. At the same time, neighboring hairs of the little pincushion bend towards the spot where the insect is trapped and hold him even more securely in place. The sticky material soon covers the insect's body and it dies by suffocation. Bits of meat or other nitrogenous matter placed upon the hairs of a Sun Dew stimulate it in the same fashion. Now an acid digestive juice is also secreted, acting upon the remains of the insect so that in

a few days nothing is left but the indigestible residue which the plant can not absorb. Over a dozen insects, in various stages of capture and disintegration, can often be seen on a single leaf, midges, gnats, ants, flies, beetles and an occasional dragonfly are the usual victims. The most interesting aspect of the Sun Dew's behavior are the activities analogous to a simple animal reflex action—the reception of a stimulus and the transmission of the impulse to a point where activity takes place. There is the transmission of an impulse from the region of hairs where the insect is caught to the more distant hairs which bend in that direction and cooperate in the capture. It has been found that the glandular hairs are more sensitive to tactile stimuli than the cells of the human tongue.

The Flycatcher (*Drosophyllum*) of Portugal and Morocco is one of the few carnivorous plants which live in dry rocky situations. The leaves are narrow and grass-like with a grooved upper surface. Numerous reddish mucilaginous glands cover the leaves with glittering beads of secretion. An insect, once alighting upon the leaf, soon finds his legs entangled with the sticky glandular substance, as it crawls along the leaf it accumulates more and more of the mucilage so that it is soon smeared with it and unable to move. Other glands produce the digestive juice which brings about the decomposition of the insect's body prior to its absorption by the plant. The sight of this plant, its twisted leaves covered with dead and dying insects glued to its surface is a memorable experience.

But most dramatic of all is the behavior of the Venus Fly Trap, a plant which seems to do everything but think when it captures its prey. Venus Fly Trap (*Dionaea*) is a small plant of sandy bogs and pinelands of the Carolinas, sometimes found in the neighboring states to the north and south. The highly specialized leaves are in the form of a basal rosette, many of the leaves lying flat on the ground. Each leaf consists of a narrow portion at the base, which functions as an ordinary green leaf, beyond this the leaf is constricted to the midrib, and then expanded again to form a broad terminal portion. This terminal part of the leaf is in two halves capable of closing together with the midrib as the hinge, the margin of each half is edged with sharp teeth, and in the center of each are three short stiff spines. When an insect chances to step on these central spines it "springs" the trap, immediately an impulse is sent to the midrib region and the leaf closes up in the same fashion as one closes an open book. This takes place rapidly enough to catch the insect, often in ten seconds. As the two halves close the marginal teeth interlock making escape difficult. The pressure of the two parts of the leaf trap is enough to crush soft bodied insects. Glands along the surface of the leaf secrete the usual mucilaginous and digestive juices which begin decomposition of the animal body preparatory to absorption. After eight to fourteen days the leaf again opens and is ready for a new victim. Suffocation takes place because the trapped insect is covered with the liquid poured out by the leaf glands. There is a record of a small frog which was caught by a Venus Fly Trap—the largest animal which authentically has been caught by a carnivorous plant.

Such plants as the Butterwort, Sun Dew and Venus Fly Trap exhibit movements in the capture of small animals which is very unorthodox for a member of the plant kingdom. It shows what a slight difference there is between the animal and plant kingdoms when certain activities considered to be prerogatives of animal life—such as movement and transmission of impulses analogous to nervous activity in animals—are also found in a goodly number of plants, some of which have been described in this chapter.



Pitcher Plants (*Sarracenia purpurea*) have leaves and leaf petioles in the form of erect hollow pitchers which act as traps in catching small insects
Hamilton, New York

The Violet Family and Its Relatives



THE VIOLET FAMILY

OF ALL our early flowers, the violets are undoubtedly the best known and a favorite with all wild flower lovers. There are some three hundred species in the Violet Family (*Violaceae*), those of the temperate regions being small herbaceous plants, those of the tropics becoming shrubs and small trees. Two thirds of these are Violets (*Viola*), represented in the United States by at least eighty different species. Violets



VIOLACEAE

Birdsfoot Violet, original form of Pansy (*center*), cultivated Pansy (*right*).

are low-growing plants which group themselves in bunches, the flowers often growing from a dense mass of foliage. They are unusual in their flower structure and in many cases there are two kinds of flowers, sterile and fertile. Each of the conspicuous flowers, consisting of five sepals, five petals and five stamens, has the lower petal extending backwards to the stem as a spur or sac which gives the violet its characteristic shape. The lateral pair of petals are narrower than the upper pair, and two of the stamens have appendages which project back into the sac of the odd petal. These flowers are usually sterile. Other, less conspicuous, flowers are produced lower down among the leaves; they bear rudimentary petals and are fertilized in the bud without the flower opening

and it is from these that seeds are produced. There are so many kinds of violets and they hybridize so readily that identifying them is a task for the trained botanist. However we can recognize several species by their general habit; some are stemless and others are leafy-stemmed, the color of the flower varies, as does the place where they grow. Violets are found in a wide range of habitats, from dry sandy plains to rich woods, wet meadows and swamps; but usually any one species prefers only one of these situations. The same species range from the Atlantic coast to the Mississippi valley, but most of the species west of the Rocky Mountains are peculiar to that region.

The stemless violets are by far the most common; among them are plants with



CISTACEAE AND PASSIFLORACEAE

Rock Rose and Beac Heather; Passion Flower.

white or blue flowers. The Large-leaved White Violet has rounded leaves among which the flowers, on stalks as long as the leaves, display their nodding white heads; it is native to shaded moist woods such as are found from Maine to Tennessee and west to the plains. The Primrose-leaved Violet has white flowers; its leaves are narrow and wavy margined. This violet is a plant of sandy soil near the seacoast from New England to Florida. The only other common white-flowered and stemless violet is the Water Violet, a plant with long narrow leaves and flowers which have delicate purple stripes in the lower petals. The Water Violet, hiding its beauty in the bogs and marshes of the eastern states, has, like all the white violets, a strong sweet fragrance. Another species, the Western White Violet, is found in the boggy meadows of all the Pacific coast states.

The blue and purple stemless species are far too numerous to describe in detail. They include the attractive lilac-blue Bird's Foot Violet, recognized by its narrowly lobed leaves and its habit of growing in dry sandy woods: the Early Blue Violet with palmately lobed leaves, common in rich woods throughout all the eastern and central states; the Marsh Blue Violet, with large heart-shaped leaves and long-stemmed flowers, at home in the moist meadows and springy hollows of woods from Maine

to Georgia and Wisconsin; the Arrow-leaved Violet of moist fields and meadows of the northeastern states; and the Western Blue Violet of wet places from California to British Columbia.

The violets with branching, leafy stems grow to be much larger plants. One of the most beautiful of the eastern species is the Canada Violet, a robust plant with large white flowers in the axils of the heart-shaped stem leaves. This violet is native to the forests of the East, from Maine to Alabama. The American Dog Violet is a blue-flowered long-stemmed species, partial to low shaded ground from the Atlantic states to Minnesota. The related Pacific coast violet, also with blue flowers, covers a wide range from California to Alaska and east to the Rocky Mountains. The Smooth Yellow Violet, or Wild Pansy, is found in the open woods of the Atlantic coast states inland to Texas. There are several western yellow violets, some found in damp grassy hollows at altitudes of eight thousand feet. The Johnny-jump-up or Wild Pansy is another western yellow violet with long branching stems.

Many of these native violets are attractive flowers, and are often found in American gardens. The parent species of the florist's varieties, however, is the Sweet Violet of Europe, Africa and Asia. Its flowers are a rich deep blue, though rose or white forms occasionally are seen.

The most famous violet is the Pansy. The species which is the ancestor of this popular garden flower is the Wild Pansy, or Heartsease, common to the cooler portions of Europe. This is a small-flowered violet with petals of three mixed colors—blue, white and yellow. Pansies are the oldest known English garden flower, being well established by the early seventeenth century. The variable coloring of the open flowers, which look like little faces, makes them a bright and cheerful sight. The word "pansy" comes from the French "*pensée*" meaning thought, and, indirectly, a remembrance. After years of breeding experiments, the pansy growers have produced many single colored varieties, chiefly yellow, white and purple; in addition to endless combinations of colors from purplish-black to blue, yellow and white. There are also large flowered varieties with flowers three inches in diameter. The best pansies were first grown in England and Scotland, where the cool moist climate was suited to their needs. But in more recent times Germany and France lead in the development of new varieties.

THE ROCK ROSE FAMILY

The Rock Rose Family (*Cistaceae*) has but a few plants in our native flora; these are small shrubs and bushy plants with flowers in which the sepals are usually more persistent and last longer than the petals. In this family we find the Frostweed or Rock Rose, the Pinweed, and Beach Heather.

Frostweed or Rockweed (*Helianthemum*) is a shrubby bush of dry soil and coastal sands; several species are common in the eastern states, others in Florida and the Gulf States, and still others along the Pacific coast. The flowers are peculiar in that they open only once, since after a day of sunshine they lose their petals. Each flower consists of five large yellow petals. Like the violets there are two kinds of flowers, large conspicuous ones and smaller ones usually without petals.

Beach Heather (*Hudsonia*) is a spreading matted shrub, with small scale-like leaves, and frequently blue-gray in appearance. The flowers are numerous, small and



The Canada Violet (*Viola canadensis*) is a robust plant with large white flowers in the axils of heart-shaped leaves. Hamilton, New York.

bright yellow with five sepals and five petals. It is a plant of dry sandy soils along the Atlantic coast and sandy lake shores and pinelands west to the Dakotas.

Pinweed (*Lechea*) is an erect plant with minute, green or purple, flowers. There are over a dozen eastern species, most of them growing along the coastal plain; a few thrive as far west as the prairie states.

THE PASSION FLOWER FAMILY

When the early Spanish and Italian travellers discovered a flower with blood-red fringe around the inside of the corolla, spike-like stamens surrounding a central pistil, and numerous other floral parts which to their imaginative minds looked like implements used in the crucifixion of Christ, they immediately named the plant Passion Flower. The Passion Flower Family (*Passifloraceae*) consists of herbaceous and climbing plants with bizarre flowers, restricted almost entirely to the American tropics, though a few species venture as far north as Pennsylvania. The showy flowers consist of five sepals united at their base to form a spreading calyx, and five petals attached to the sepals; the coloring is very startling in pastel hues of lavender, yellow, green, blue and red. The corolla is fringed on the inside, around the stamens and pistil, with many hair-like filaments radiating towards the center of the flower.

The Yellow Passion Flower (*Passiflora*) is a vine with greenish-yellow flowers found in the thickets of Florida and adjacent states, sometimes occurring as far west as Kansas and Texas. Another species, known as Maypop or Apricot Vine, is common in the southeastern states and has more showy purple flowers and an edible yellowish fruit the size of a hen's egg.

The ornamental Passion Flowers are prized for their extravagantly colored and constructed flowers; they are derived from species native to Central America, Mexico and Brazil. There are also edible species, such as the Granadilla of Costa Rica and the Water Lemon of the British West Indies. These can be grown in the United States only in the warmest and most frost free portions of California and Florida.

THE PAPAYA FAMILY

The Papaya Family (*Caricaceae*) includes a few tropical and sub-tropical shrubs and trees with edible fruit. The main trunks are unbranched and stout, grow to a height of fifteen or twenty feet and are crowned at the top by a mass of large palmately compound leaves. The flowers (reddish or yellow) and fruits grow just beneath the leaf cluster; each fruit is melon-shaped and may weigh as much as fifteen pounds. The Papaya (*Carica*) is native to the hammocks and to the pinelands of southern Florida; it is frequent on the Keys and through the Everglades. The fruits have a pink or yellow flesh and a muskmelon flavor. The papein of commerce is secured from the juice of papayas.

THE BEGONIA FAMILY

Some plants are cultivated because of their showy foliage, as well as for their flowers; such are the Begonias. The Begonia Family (*Begoniaceae*) is one of succulent small plants and shrubs widely distributed through tropical America, Asia and Africa. The flowers are in clusters, each flower consisting of dissimilar petals, differing in

CHAPTER XXII

The Saxifrage Family and Its Relatives



THE SAXIFRAGE FAMILY

THERE are some seven hundred widely distributed small and shrubby plants in the Saxifrage Family (*Saxifragaceae*). Among them are the wild flowers Alum Root, Miterwort, False Miterwort, Woodland Star, Grass of Parnassus and the Saxifrages; a few shrubs such as Mock Orange, Syringa, Hydrangea and Deutzia; and some plants with edible fruits as the Currants and Gooseberries. The flower of the Saxifrage Family has typically five sepals, five petals and usually five or ten stamens; beneath the calyx and corolla the stem is enlarged to form a saucer-shaped or bell-shaped base to the flower. The fruit may be a juicy berry or a dry capsule.

Alum Root (*Heuchera*) is a rather stout stemmed plant with broad, shallowly lobed leaves, growing to a height of three feet. The small flowers—white, green, yellow or purple in color—grow in terminal clusters. Alum Root grows on dry rocky banks, and is found in the woods of most of our states from coast to coast. One species, native to New Mexico and Arizona, has bright red flowers; it is often found in gardens under the name of Coral Bells.

Miterwort (*Mitella*) is a slender primly erect plant of rich woods in all our states. A common eastern species has the leaves in a basal cluster, with two conspicuous stem leaves opposite each other, below the elongated terminal cluster of small white flowers. Each flower is shaped like a tiny bell with five fringed petals. The name is due to the cap-shaped form of the fruit—"mitella" meaning little cap. A closely related genus, False Miterwort or Foamflower (*Tiarella*) is more restricted in its range, being found only in the rich rocky woods of New England, south to the Carolinas and west to Minnesota; a northwestern species ranges from northern California to Washington. The flowers of False Miterwort are borne in a slender terminal spike, both the sepals and petals being white. The petals are not fringed as they are in the Miterwort.

Grass of Parnassus (*Parnassia*)—named for the famed Mount Parnassus—is a plant of swamps, wet meadows and riverbanks, common to the states east of the Mississippi River; a few species are known from the mountain meadows of the Pacific coast states. The small oval leaves form a basal cluster from which arise the tall flowering stalks, bearing rather large white flowers, each with five sepals and five white petals veined with green.

Prairie Star or Woodland Star (*Lithophragma*) is a plant found in dry rocky places of our midwestern states and on grassy mountain slopes of the Pacific coast. Each flower of the terminal cluster has the bell-shaped appearance characteristic of so many members of the Saxifrage Family; the petals are white or pink, usually fringed.

There are at least several hundred species of Saxifrages (*Saxifraga*) found in temperate regions, some of them prized as rock garden and border plants. The name means "rock-breaker", interpreted as meaning either that they grow in rocky crevices which they seem to have broken open in gaining a foothold, or that they were once



SAXIFRAGACEAE

Grass of Parnassus and Alum Root.

considered a cure for gall stones. Saxifrages, for the most part, are low-growing rock plants with a dwarf habit and leaves in basal rosettes. The flowers are produced on long stalks, in terminal clusters, each with a five-lobed calyx and five entire, white petals. Many of the species perch in inaccessible crevices and on the ledges of rocky cliffs. Various species are common in all parts of the United States.

The Mock Orange, or Wild Syringa, (*Philadelphus*—a name given to it by Linnaeus for no obvious reason) is a deciduous shrub with oval-pointed leaves and snowy white fragrant flowers. Some thirty species are found in North America and Asia, the tallest growing to a height of twenty feet. Unfortunately the scientific name for Lilac is *Syringa*, leading to some confusion in referring to these two flowering shrubs. The Mock Orange flowers have four calyx lobes and four petals; it ranges



Miterwort (*Mitella diphylla*) is a slender and primly erect plant of rich woodlands, with terminal clusters of small white flowers. Hamilton, New York. Photograph by O. B. Stanley.

through the mountains of the east from Virginia to Florida. Another species occurs in the rocky mountains of the southwestern states, and on the wet hillsides of the Northwest. The cultivated *Syringa* comes from Armenia and southern Europe; it often escapes, and is found naturalized in some of the midwestern states.

Hydrangea (*Hydrangea*) is another deciduous shrub of the Saxifrage Family with conspicuous masses of flowers, often in dense heads. Our native species are found along river banks and in the woods of the southern coastal plain states, being most common from the Carolinas to Louisiana. There are four to ten sepals and



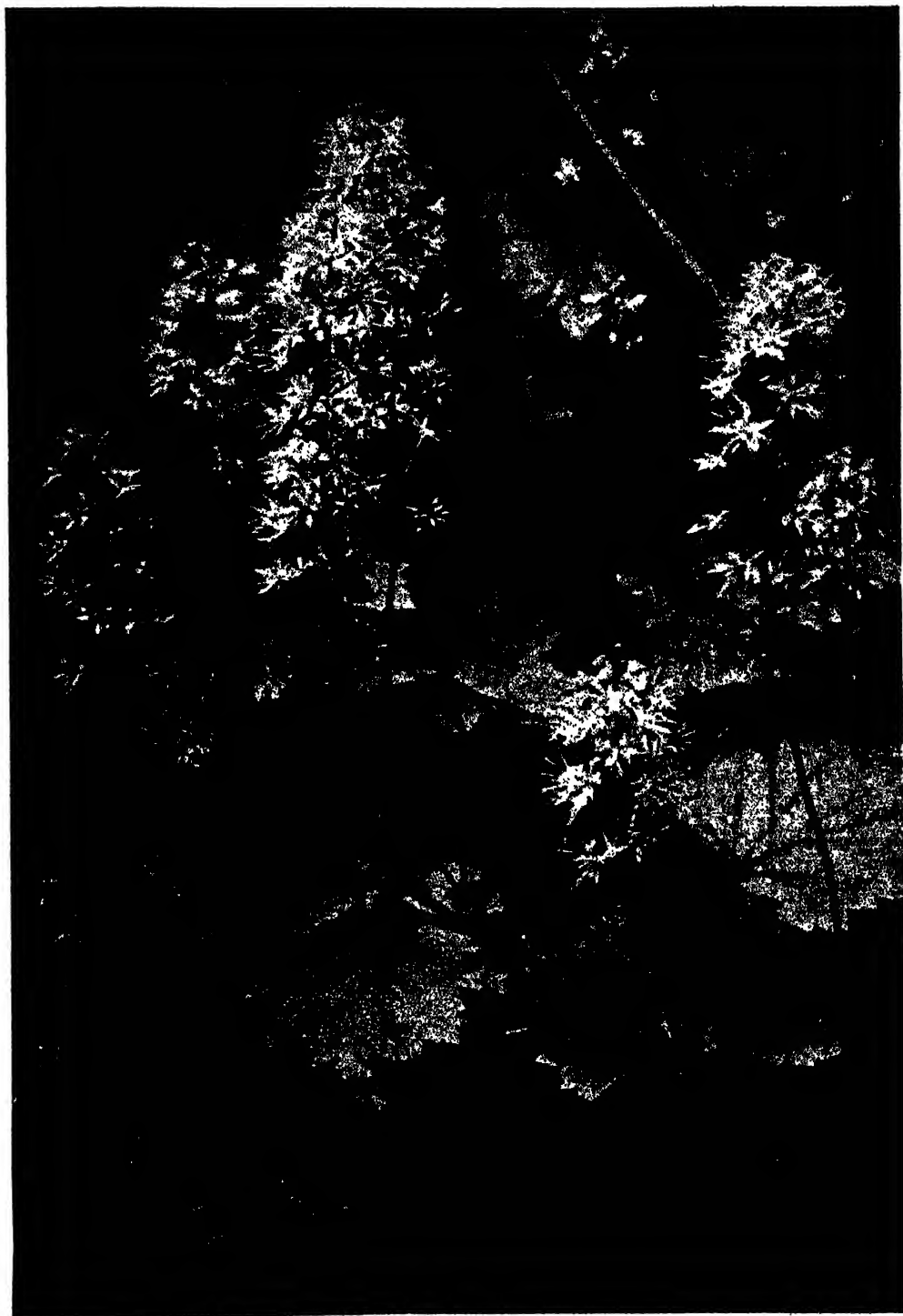
SAXIFRAGACEAE

Saxifrage and Syringa (upper right), Hydrangea (lower right).

petals, the latter varying in color from white to pink and blue. The garden *Hydrangea* with its large showy flower heads, common as a lawn shrub in the northeastern states, is a species native to China and Japan.

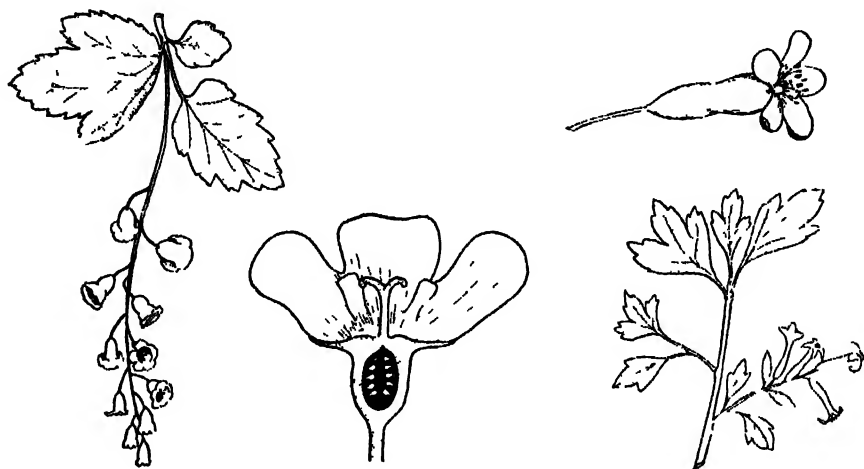
Deutzia (*Deutzia*) is a related ornamental shrub with showy white or bluish flowers, usually with five petals, in an open cluster. It has been introduced from Asia and Mexico.

The only member of the Saxifrage Family that is of any economic importance is the Currant and Gooseberry genus (*Ribes*) of which there are many native species in various parts of the United States. These are bushy plants, some with prickly stems, common to north temperate regions. The scientific name comes from the old Arabic term for the edible berry. The flowers, usually in clusters, are small, white or



False Miterwort (*Tiarella cordifolia*) is a member of the Saxifrage Family found in rich or rocky eastern woodlands. Hamilton, New York.

yellow, with five small petals and colored sepals. Currant and Gooseberries are crop plants only in the cooler parts of the United States. The Golden Currant of our western states is a native bushy plant with yellow flowers, often grown as an ornamental shrub. The most southern species appears in the Blue Ridge Mountains of North Carolina. Most of the varieties are found in the New England and north central states. A few species are of importance since they act as alternate hosts for the White Pine Blister Rust fungus, and in regions of infection the wild species of *Ribes* have to be eradicated. The garden varieties producing the edible currants are usually the Red Currant of western Europe and the Black Currant from Europe and Asia.



SAXIFRAGACEAE.

Red Currant (left), habit and section of flower, Gooseberry flower (upper right) and Golden Currant (lower right)

The Gooseberry is a prickly-stemmed species from Europe and northern Africa. Many native Gooseberries are found in the Atlantic coast states, the prairie states and in the mountainous areas of the Pacific coast.

THE WITCH HAZEL FAMILY

The Witch Hazel Family (*Hamamelidaceae*) includes a few shrubs and trees common to the eastern and central states; there are about fifty species found in North America, Asia and South Africa. Our native representatives of the family are the Witch Hazel and the Sweet Gum.

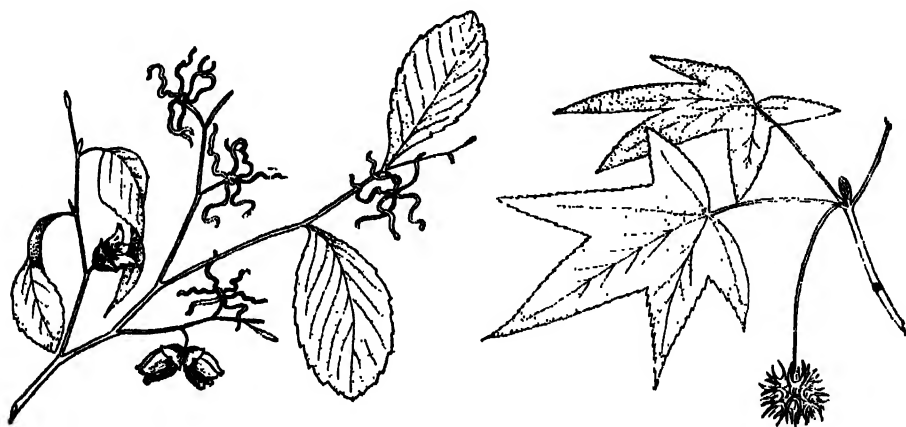
Many a person, wandering through the eastern woods in late October or early November, has been surprised to find a small tree covered with its bright yellow flowers at this unseasonable time. This autumnal flowering habit of one Witch Hazel (*Hamamelis*) sets it apart from most plants. Witch Hazel species are small trees of forest margins and stream banks, found from New England southward to Florida and west to Minnesota. The leaves are small and oval. The flowers consist of four twisted, narrow ribbon-like petals, bright yellow in color, and a small four-parted brown calyx. These little flowers form cheery spots in the otherwise drab and leafless



Sycamores (*Platanus occidentalis*) are conspicuous trees because of their spotted trunks, marked with bleached and whitened areas where the outer bark has fallen away. Claremont, California.

eastern woodlands. The astringent character of the bark and leaves makes it useful in preparing various extracts.

The Sweet Gum (*Liquidambar*) is one of the large forest trees of the Atlantic coast, old specimens being over a hundred feet in height; unusually large, venerable specimens are found in the Florida hammocks. The rather fragrant juice of the twigs is responsible for the name; "liquidus" meaning fluid and "ambar" the Arabic term for amber. The Sweet Gum leaves are palmately lobed and the flowers, lacking petals, are grouped in small clusters. The heavy hard wood is close-grained and suitable for various building purposes and for cabinet making.



HAMAMELIDACEAE

Witch Hazel and Sweet Gum.

THE SYCAMORE FAMILY

The Sycamore Family (*Platanaceae*) is a small family with one common genus, the Plane Tree (*Platanus*) which is also known as the Buttonball and the Sycamore. This is a widely distributed American tree found throughout the states wherever there is sufficient water for woody growth. It is a characteristic tree of low wet ground and river valleys. The southwestern species is the common tree in arid canyons and washes even though water is in them only for a few weeks in the year. These trees have conspicuous bleached and whitened areas on the trunk where the outer dark bark has peeled or checkered off to leave the lighter under bark. In the southwest, in winter, the leafless limbs display great numbers of compact green "balls" of Mistletoe which live parasitically upon the trees. The leaves of the Sycamore are broad, large and palmately lobed; the inconspicuous flowers form a rounded fruit which is really a ball of closely packed nuts, each of the latter being the true fruit.

THE ORPINE FAMILY

Certain families of flowering plants have adapted themselves for a life in alpine or rocky dry regions by developing thick succulent leaves which act as storehouses of water. The Fig Marigolds were such a family, related to the Pinks. Another family



Live Forevers (*Icherea*) form gray-green rosettes which cling to the vertical face of rocky cliffs in their native haunts in Mexico. Ensenada, Mexico

and as a potted plant Live Forever, native to Europe and Siberia, is an erect garden plant with toothed leaves and numerous pink or white flowers

River Lock (*Tillaeastrum*) is the sole member of the family common to damp or wet places, it is a small annual plant living in water or on mud, with opposite elliptical leaves and greenish-white flowers growing singly in the axils of the leaves

The Roseroot (*Rhodiola*) is a cliff inhabiting plant with comparatively thin elliptical leaves, a woody rootstock and yellow, purple or green flowers growing in a dense terminal cluster. Species are found along the coastal cliffs of Maine, in the Blue Ridge Mountains and among the Sierra Nevadas

Among the better known succulent plants under cultivation are the House Lock and Hen and Chickens (*Sempervivum*—which means "living forever") Sixty species are found in the mountainous parts of the Old World. The plants form compact rosettes of stemless fleshy leaves, often spotted with red towards the tip. From the rosette of thick leaves an erect flowering stalk produces flowers generally in some shade of yellow or rose-purple. Each flower has six sepals and six petals, thus differing from the four and five parted flowers of the related *Orpines*. In the Hen and Chickens the young plants develop as rosettes from the stem of the parent and cluster about its base, but they are loosely attached and easily separate, rolling off to root and grow by themselves. Various cultivated varieties come from Austria, Russia and the Orient.

Stemless rosettes of thick succulent leaves are also characteristic of the Live Forever (*Echeveria*—named for the great Mexican botanical artist A. Echeverría). These New World counterparts of the *Sempervivums*, are found only in Mexico, southwestern United States and Central America. Their gray-green rosettes form a striking contrast to the reddish-brown vertical cliffs on which many of the species seem to cling so precariously. Over a dozen species are found in rocky canyons and on stony slopes of southern California. The yellow or red flowers are borne in terminal clusters on tall flowering stalks.

The Jade Plant (*Crassula*) owes its scientific name to the Latin term for "thickish", applied to the fleshy leaves. It is native to southern Africa and Asia, and is cultivated as a greenhouse or pot plant because of the foliage, which is often made up of thick leaves of unusual shape. The flowers are small and usually white, rose-pink or yellow.

Most flowering plants rely only upon seeds as the method of reproduction. Therefore the Life Plant or Live Leaf (*Bryophyllum*) is most unusual in having a second method as well. The scientific name means "sprouting leaf" and is aptly applied to this strange plant of tropical America, Asia and Madagascar. Any one of the slightly fleshy, lobed leaves, falling to the ground, is able to produce young plants from the notches along its margin. Tiny buds appear at each notch in the leaf, soon become young plants attached to the edge of the leaf. After these root themselves in the earth they become self-sustaining and start a new generation. The Life Plant is grown because of this foliage peculiarity rather than for the purplish-green pendant flowers. It has become naturalized in the hammocks and waste places of Florida.

The Pea Family



THERE are only two other families of flowering plants (the Grasses and the Roses) which have contributed as many useful species as has the Pea Family; and there are few families with more members. The Pea Family (*Leguminosae*) includes some twelve thousand species distributed throughout the temperate and sub-tropical regions of the world, and adapted to a variety of habitats from seashores and eastern



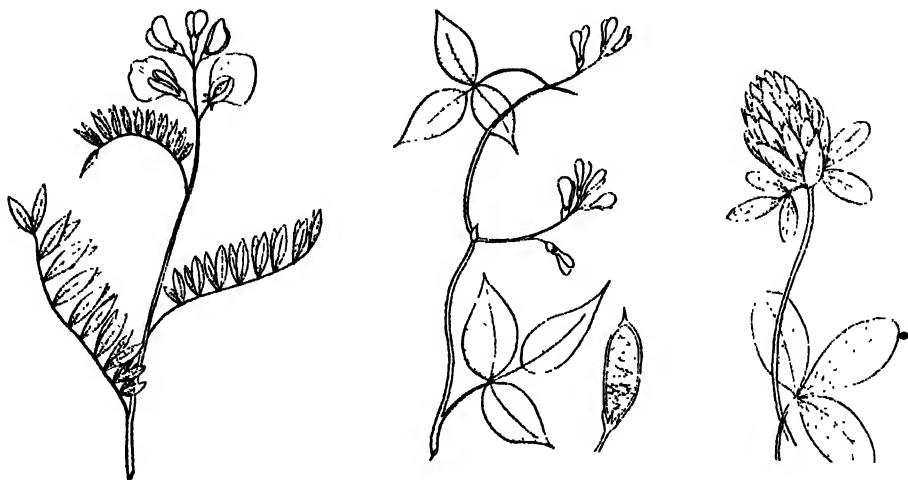
LEGUMINOSAE

Lupine, Wild Indigo and Rattlebox.

woodlands to deserts and rocky canyons. Many of them are particularly abundant in the grassland areas of our central states. Among the members of the Pea Family are many common wild and cultivated flowers, a goodly number of shrubs and trees, and important food and forage plants. Few families are as easy to recognize; for a typical representative of the Pea Family has compound leaves, an irregular butterfly-like flower and a pod for fruit. In most species, the calyx is tubular, the two uppermost segments united and the three lower forming a lip. The corolla usually consists of five petals, the uppermost being large and conspicuous, the two lateral ones smaller

with narrowed bases, and the two lowermost united to form an upturned keel. Exceptions are found in the flowers of the Acacias and Mimosas. The compound leaves are of two types; in one, known as a palmately compound leaf, the leaflets radiate out from the central stalk like the fingers of a hand. In the other, or pinnately compound leaf, the leaflets are arranged on either side of the mid-stalk resulting in a feathery foliage spray.

Wild flowers, without representatives in our flower or vegetable gardens, include the Partridge Pea, Wild Senna, Wild Indigo, Goat's Rue, Rattlebox, Groundnut,



LEGUMINOSAE

Goat's Rue, Hog Peanut and Red Clover.

Hog Peanut, Wild Bean, Wild Licorice, Sweet Clover, Bush Clover, Prairie Turnip, Prairie Clover, the Trefoils and Locoweed.

Flowers and herbaceous species which have become of importance as ornamentals or food plants include the Lupines, Vetches, Wistaria, Alfalfa, the Clovers, the Peas, Beans and Peanut.

The shrub and tree members of the family are the Redbud, Locusts, Coffee Tree, Yellow Wood, Wild Tamarind, Mesquite, Desert Ironwood, Smoke Tree, Palo Verde and Cat's Claw.

WILD FLOWERS OF THE PEA FAMILY

The Partridge Pea (*Chamacrista*) is sometimes termed the Wild Sensitive Plant because the pinnate leaves, with twelve to forty small leaflets, are sensitive to the touch somewhat like those of the Sensitive Plant (*Mimosa*). It is a low-growing plant of dry sandy soils occurring in all of the eastern states; the yellow flowers are produced in small clusters in the axils of the leaves.

Wild Senna (*Cassia*) is a long stemmed plant with pinnately compound leaves, each of eight to twenty leaflets; in the axil of the leaves are clusters of yellow flowers. The eastern species grows on moist ground, while a western representative thrives in the deserts of the Southwest.



Crown Vetch (*Coronilla varia*) is an Old World genus common in American gardens and often found naturalized along roadsides. New York Botanical Garden.

Wild Indigo or Horsefly Weed (*Baptisia*) is a profusely branching, spreading plant of dry sandy habitats in the eastern and coastal plain states; other species are native to the prairies. The compound leaves consist of only three leaflets; showy yellow flowers form dense terminal clusters.

Goat's Rue and the Hoary Peas (*Tephrosia*) are chiefly confined to the eastern and southern states. Goat's Rue is also a plant of dry sandy soils from New England to Louisiana and Minnesota; it is characteristically covered with fine silky hairs. The pinnately compound leaves are made up of nine to twenty-five leaflets, with the yellow or red flowers clustered in a terminal mass. Fifteen or twenty other species, known



LEGUMINOSAE

Bush Clover, Tick Trefoil and Locoweed.

as Hoary Peas—with pink, purple, red or white flowers—grow in the dry pinelands of the coastal plain.

Rattlebox (*Crotalaria*) is a peculiar member of the family, with an inflated pod in which the seeds rattle about; "krotalon" is the Greek word for rattle. Most of the species are found in the southeastern states; a common form with simple leaves and yellow flowers grows in sandy soil along the coast from New England to Texas.

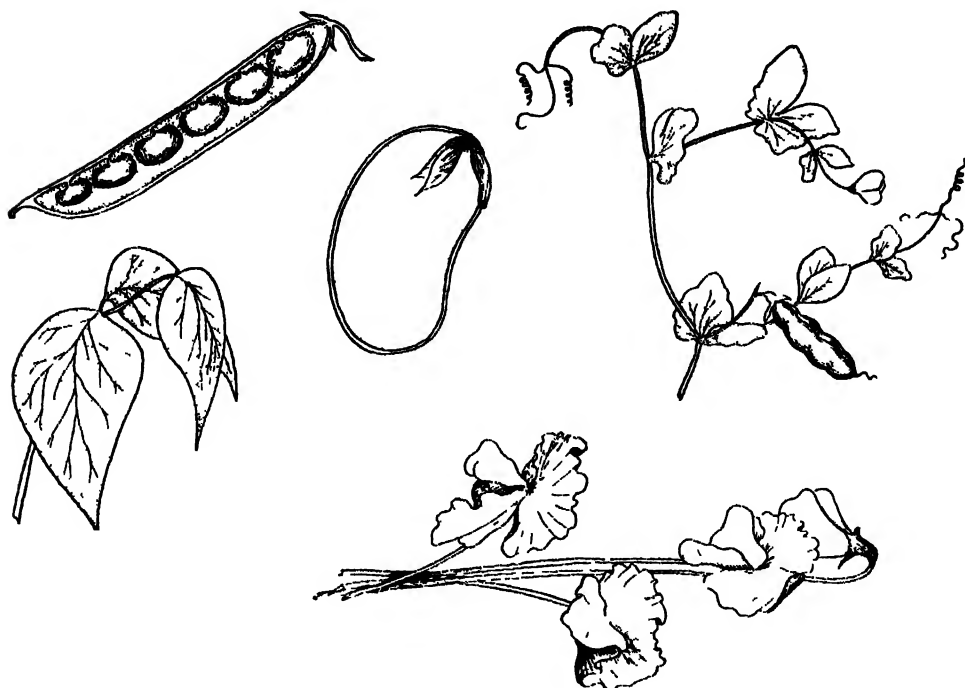
There are three trailing and climbing genera common to the eastern portion of the United States, sometimes occurring as far west as Texas and Kansas. The Groundnut or Wild Bean (*Apios*) is a plant of moist woodlands, with five to ten leaflets in each compound leaf and brownish-purple flowers in small clusters in the axils of the leaves. Hop Peanut (*Amphicarpa*) is a twining plant of similar moist woodlands; each compound leaf is made up of only three oval leaflets, and the axillary clusters of flowers are white or purple. Trailing Wild Bean (*Strophostyles*) prefers the more open sandy fields and thickets; it too has a three-parted compound leaf, but the flowers are greenish-purple.

A widely distributed plant recognized by its thickened sweet roots and glandular-dotted leaves is Wild Licorice (*Glycyrrhiza*) which requires moist woods or rich



The ashy-gray ourines of the Smoke Tree (*Dalea spinosa*) form filmy masses in the sun-baked washes of the Colorado Desert. Near Palm Springs, California.

clothing, we remove them and throw them away, little realizing that in doing so we are aiding the plants in their seed dispersal. The Trefoils exemplify those plants which have armed their fruits with barbed spines which fasten themselves to animals and are thus carried to new homes. The pods break into triangular sections, each with its seed. These plants are herbs or vines of temperate and tropical America and Asia, with over twenty-five species common to our central and western states. The leaves are divided into three leaflets and the small reddish-purple or white flowers are borne in loose clusters.



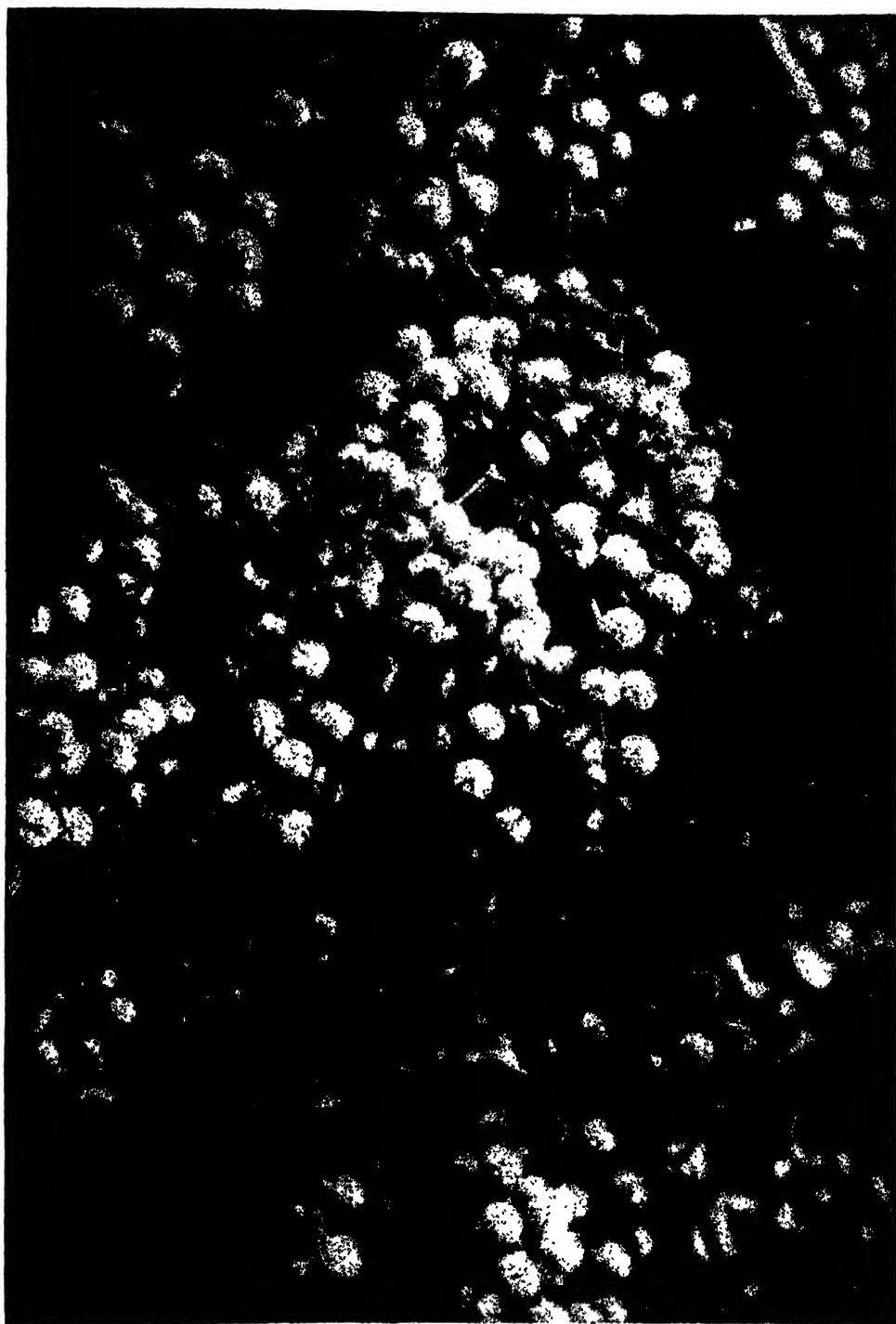
LEGUMINOSAE

Kidney Bean, plant and fruit (*left*), Lima Bean seed (*center*), Garden Pea (*upper right*), Sweet Pea (*lower right*)

Locoweed (*Astragalus*) is a large genus of some five hundred species of plants, most abundant in western and central United States and Asia. The Eastern Locoweed or Rattlebox grows in the Atlantic coast region and has pinnately compound leaves and cream-colored or greenish flowers in loose clusters. Most of the Pacific coast species are plants of dry and arid regions, with rose, lavender, scarlet or white flowers and the usual pinnate leaves. The Woolly Locoweed is one of the Prairie species with bright purple flowers.

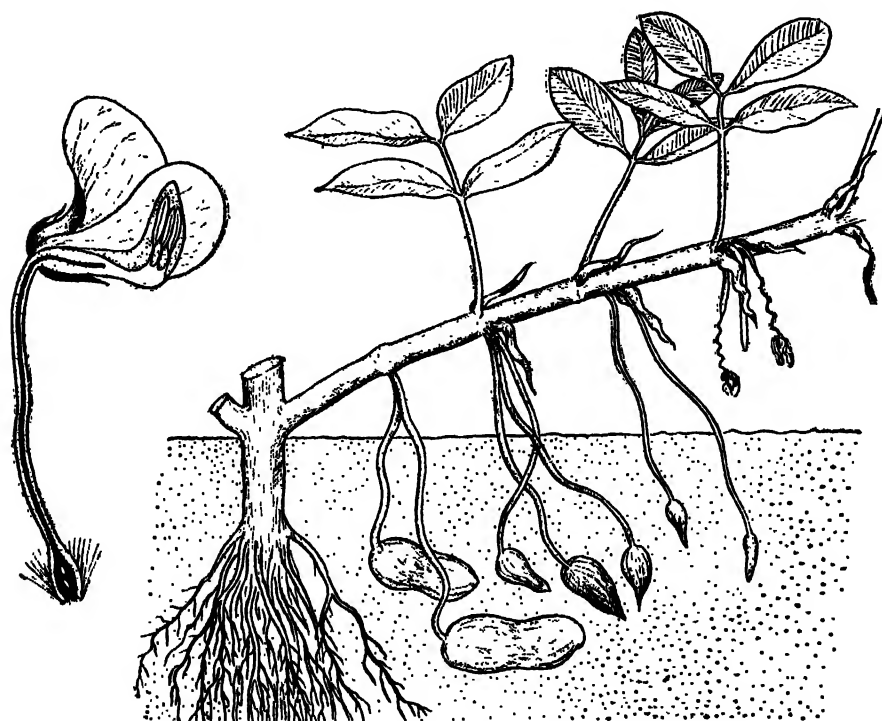
FOOD AND ORNAMENTAL PLANTS

The Lupines (*Lupinus*) are beautiful plants even though their name, derived from the Latin for "wolf", indicates that these plants were once thought to rob the soil of



The spherical golden-yellow flower clusters of Acacia trees (*Acacia*) are both colorful and decorative along the California streets in early spring. Pomona, California.

mineral food. There are three hundred species, most common in western United States, Mexico, South America, Africa and the Mediterranean region. The foliage is distinctive, each leaf being palmately compound with narrow leaflets. The showy flowers are grouped in dense erect spikes which rise gracefully above the more or less basal foliage. Lupines vary in color from the common blue or purple to red, white and yellow varieties. There is only one common species of Wild Lupine in the northeastern states; it is a plant of sandy sunny habitats. The number of species increases as



LEGUMINOSAE

Peanut plant, showing habit of forcing the fruit underground.

we go south or west; there are six species along the coastal plain, nine on the prairies, and west of the Rocky Mountains we find two dozen native species. A natural wild flower show to which thousands make an annual Californian pilgrimage is the miles upon miles of Lupine covering the grassy slopes of the Bakersfield valley. The densely growing Lupines transform the countryside into a great purple sea. Other western species thrive on sandy banks and in the deserts. There is even a Tree Lupine—a shrub five to ten feet high—in California, with fragrant yellow flowers. Cultivated Lupines are common in gardens; these are usually descendants of European species. The Yellow Lupine and the Blue Lupine come from southern Europe, while the White Lupine is native to Asia and Europe.

Wistaria (*Wistaria*) commemorates the name of a famous American professor

of anatomy at the University of Pennsylvania—Caspar Wistar. It is a familiar shrub or vine with the compound leaves and pea-like flowers characteristic of the family; two species are native to eastern United States and two others are found only in eastern Asia. The Kentucky Wistaria, with light blue to purple flowers in pendant clusters, is found in the woods from Illinois southward; the other native species, American Wistaria, has lilac-tinted flowers and is found in lowlands from Virginia southward along the coast to Texas. Cultivated Wistarias, common as vines covering porches and trellises, are either the Japanese Wistaria or the Chinese Wistaria—plants native to the woods and stream banks of those two countries.



LEGUMINOSAE

Redbud and Kentucky Coffee Tree.

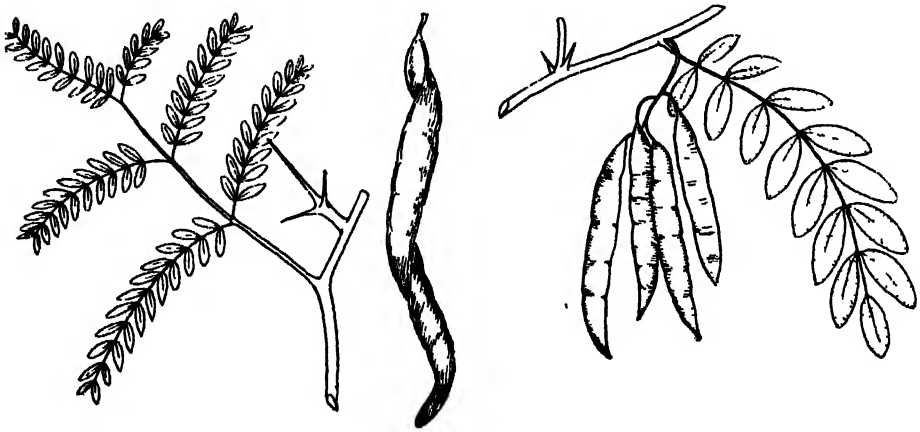
Scotch Broom (*Cytisus*) is a plant of the Old World which is commonly cultivated especially in the southern states and California; often there are three leaflets to each leaf, at other times only one—but the leaves are not as conspicuous as the stiff green broom-like stems which while still leafless produce the yellow pea-shaped flowers. Scotch Broom is a large shrub, sometimes growing to be a small tree.

The Crown Vetch (*Coronilla*) is another Old World genus, common about the Mediterranean—a trailing plant with eleven to twenty-five leaflets in each compound leaf and pinkish white flowers in terminal clusters. This Vetch has become naturalized in this country and is often found along roadsides and in waste places. The garden species are usually yellow-flowered.

Alfalfa (*Medicago*) is a European member of the Pea Family which has become thoroughly naturalized in the United States. It originally grew wild in western Asia, and was known to the Greeks and Romans. It was brought into the United States from Mexico by the Spanish padres, and from California cultivation of alfalfa has spread eastward. Alfalfa has three-parted compound leaves and blue or purple flowers in a terminal cluster. It serves a double purpose, being both an excellent forage plant, and a soil enricher (known to farmers as "green manure"). Nitrogen-fixing bacteria

live in swellings on the roots of Alfalfa, Peas and Beans, thus growing these plants means putting atmospheric nitrogen into the soil in the form of nitrates

There are few children who have not become familiar, probably unknowingly, with the Pea Family through a search for one of its common representatives—the Clover. For some reason a four-leafed Clover has been the symbol of good luck for centuries. The common Clover (*Trifolium*) is so named because "tres folium" means three leaves, in reference to the well known three-parted compound leaf. The small flowers are generally fragrant, and clustered in a dense head. Three hundred species are scattered through the north temperate zone, our native species being particularly abundant in the Midwest and Southeast, and on the grassy slopes of the Pacific coast. Many of the European varieties introduced as forage crops, have escaped and can



LEGUMINOSAE

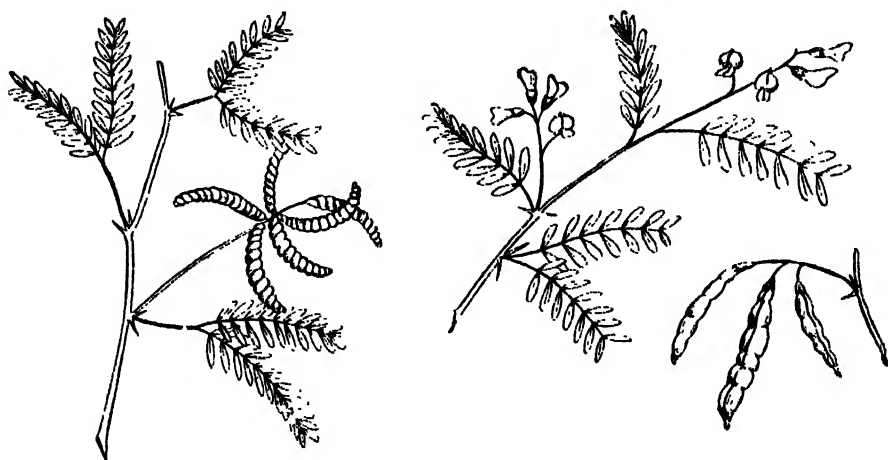
Honey Locust and Yellow Locust

be found wild in all our states. The only species native to the northeastern states is the Buffalo Clover, whose rose-red flowers are marked with white. Naturalized species include the Yellow Clover, the abundant roadside and field Rabbit Foot Clover with white flowers, and the Crimson Clover. Cultivated species are numerous, the White Clover is considered the original shamrock of Ireland, the Red Clover is a plant requiring a humid atmosphere and moderate temperature extremes, and the Swedish Clover is a tall branching plant with rose or pink flowers which are highly esteemed as honey plants. Clovers are members of the Pea Family which became cultivated relatively late in historical times, perhaps about 1600 A D, this is surprising since native species were common in the Mediterranean region.

The Vetches (*Vicia*) are climbing and trailing plants with a variable number of leaflets and flowers which are mostly lavender or purple. The Common Vetch of roadsides and fields has become naturalized from Eurasia, it has eight to fourteen leaflets in each compound leaf. A native species is the Sand Vetch of the southern coastal plain states, with only two to six leaflets. One of the edible Beans of Europe, commonly cultivated before the discovery of America, is the Windsor Bean or Broad

Bean, a species of *Vicia*, native to Algeria. This was extensively cultivated in northern Europe and used in this country to some extent during the Colonial Period, but is now almost unknown. The fruit is a large thick pod with brown "beans".

The common Kidney Bean (*Phaseolus*), native to tropical America, was being cultivated by the natives before the arrival of the Spaniards. It was unknown in Europe until after the discovery of America, and is one of the major contributions of the New World to the food plants of man. They soon became the common "haricot" of the French and the "frijoles" of the Spaniards. Kidney Beans have three-parted compound leaves and white, yellow or blue flowers; the slender pod may be eaten with the seeds, as in the string beans, or the seeds may be used by themselves as the typical "beans" of our diet. The Lima Bean is a related species of *Phaseolus* with broad flat



LEGUMINOSAE

Mesquite and Desert Ironwood.

Pods and flattened seeds; it is native to South America, bearing the name of the capital of Peru. Another species, grown for its flowers rather than its edible seeds, is the Scarlet Runner Bean of Mexico and South America. There are two native species of *Phaseolus*; the Bean Vine of woods and thickets from Florida to Texas and Minnesota has purple or white flowers, while the purple flowering Wild Bean is found only in the pinelands and hammocks of the coastal belt from North Carolina to Mississippi. The Soy Bean (*Sofa*) has recently come to public notice as a source of oil which can be made into rubber substitutes, soaps and lubricants. It has been cultivated in its native home of Japan and China as a food and sauce plant for centuries. Recently in China, Soy Beans have been made into a milk substitute containing practically all of the essential elements found in cow's milk. In the United States it is grown for industrial purposes and as a forage crop.

The Garden Pea (*Pisum*) has for a long time been native to Europe but originally came from western Asia; seeds have been found among the prehistoric Swiss lake dwellings which date back to the Bronze Age. So many centuries have passed since

peas were first cultivated that the ancestral type is not known. In the Garden Pea the pod contains seeds (peas) in which the food is stored in the hemispherical seed leaves or cotyledons. The pinnately compound leaves terminate in the familiar tendrils with which the peas are able to climb up their supports. The Sweet Pea (*Lathyrus*) of our gardens is one of the most popular annual plants for producing cut-flowers. There are two hundred species of the genus in the Americas, Europe, Asia and Africa; the usual garden Sweet Pea comes from Italy, and produces flowers in a number of delicate tints of blue, red and yellow as well as white. Related native species, known as Pea Vines or Vetchlings, grow in the coastal plain and prairie states.

The Peanut (*Arachis*) is not a "nut" in the botanical sense, but a typical pea or bean seed in a pod. It is an annual plant of Brazil with axillary yellow flowers which produce their fruit in a most unusual fashion. After fertilization the ovary stalk elongates and bends downward, thus burying the developing pod in the ground. The Peanut therefore is one of the few true fruits actually found underground. Peanut plants require a sandy soil in a region with a long warm growing season; they are raised in the states south and west of the District of Columbia.

TREE MEMBERS OF THE FAMILY

A few of the thousands of species in the Pea Family have developed woody tissues and arrived at the state of being trees. In the eastern states we find the Redbud, Honey Locust, Yellow Locust and Kentucky Coffee Tree. Farther to the south there are Yellow Wood and Wild Tamarind. While in the arid Southwest most of the desert trees belong to this group—Cat's Claw, Mesquite, Desert Ironwood, Palo Verde and Smoke Tree.

The Redbud Tree (*Cercis*) is a small flowering tree found along streams and rich lowlands in most of the states east of the Mississippi River except in New England and New York. Another species ranges from Texas west to southern California. The large heart-shaped leaves often appear after the flowers, which grow in showy rose-purple clusters and clothe the branches with masses of color. The fruit is the pod typical of the family. This tree is especially beautiful in woodlands of the southern states where it forms splashes of color among the light green of the new foliage of the deciduous trees.

The Honey Locust (*Gleditsia*) is a much larger, stouter tree with trunk and branches often covered with large branching spines; it occurs in about the same range as the Redbud. Some of the large pinnately compound leaves have the numerous leaflets again subdivided into smaller leaf segments. This repeated subdivision of the leaf, so common among the ferns, is found among many of the tree species in the Pea Family. The inconspicuous green or white flowers grow in small clusters in the axils of the leaves. The fruit is an unusually large twisted pod, twelve to eighteen inches in length. Honey Locusts are common as shade and park trees in the eastern states.

Another large deciduous tree, commonly found in the northeastern states and native to the east-central region, is the Yellow Locust (*Robinia*); Yellow Locusts have deeply furrowed bark and rugged angular habit of branching. At the base of the compound leaves, consisting of seven to nineteen leaflets, are pairs of small spines. The flowers are large and showy hanging from the branches, like the Wistaria in

clusters white or pink in color. The fruit is a relatively small straight pod three inches in length.

The Kentucky Coffee Tree, also known as Mahogany (*Gymnocladus*), is a fairly large tree of rich bottom lands from New York south to Oklahoma and west to Minnesota. The large leaves are pinnately compound and with the leaflets subdivided into smaller segments as in the Honey Locust. The flowers are greenish-white and produced in loose open clusters; they are succeeded by broad dark brown pods six to ten inches in length. The only other species is native to central China. The name was locally given to the tree because the seeds were tried by the early settlers as a substitute for coffee.



LEGUMINOSAE

Smoke Tree and Palo Verde.

Yellow Wood (*Cladrastis*) is a tree of limestone cliffs and river banks in Tennessee and Kentucky and a few adjacent states. It is a small tree with smooth gray bark and compound leaves divided into seven to eleven large oval leaflets. The white flowers are in drooping clusters like the Yellow Locust. A yellow dye can be made from the clear yellow heartwood.

Florida is the gateway by which many tropical plants enter the United States; this is particularly true of the Figs and Papayas already described. The Wild Tamarind (*Lysiloma*) is another Florida representative of a genus with the remaining species in the American tropics. It is a small tree with stout spreading branches which bear compound leaves whose leaflets are again subdivided into more delicate leaf blades. Minute white or greenish flowers are clustered in globular heads.

Moving westward to the arid wastes of western Texas, New Mexico, Arizona and California we find that the Pea Family has made itself at home in these inhospitable habitats. In the gray gravelly stretches of the Southwest, from the mountain mesas to the floor of Death Valley, the Mesquite or Screw Bean (*Prosopis*) forms welcome spots of green with a semblance of shade which protects man and beast from the scorching sun. Mesquite is a spiny shrub or tree with compound leaves subdivided

into delicate and frail-looking leaflets ; the small greenish-white flowers are borne in axillary spikes, producing straight or twisted pods often used as food by animals and the native Indians. There are three American species, others in South America, tropical Asia and Africa.

Desert Ironwood (*Olneya*) perpetuates the name of an early American botanist—Stephen T. Olney. It is a shrubby tree of the southwestern deserts, its short trunk and dense head of spiny branches covered with Mesquite-like leaves and purple or violet flowers in small axillary clusters.

One of the memorable sights of the Colorado Desert, in California, is the ashy gray outline of a Smoke Tree (*Dalea*) against a background of blue distant mountain ranges. This desert shrub and small tree is also stout and spiny, conspicuously gray because of the hoary twigs and spines. The leaves are inconspicuous and short-lived, scattered among the spines, in the axils of which small violet-blue flowers are produced.

A conspicuous deciduous tree among the giant Suaharo cacti of Arizona is the green-barked Palo Verde (*Cercidium* and *Parkinsonia*), with several species in the Southwest. Palo Verde is a stocky tree with an interlocking mass of spiny branches forming a dense low-headed tree ; the small compound leaves are short-lived. Bright yellow flowers are borne in small axillary clusters.

Very appropriately named is Cat's Claw (*Acacia*) a thorny member of the genus native to rocky canyons and gravelly mesas from Texas to California. The leaflets are subdivided into more delicate smaller segments ; and the flowers are light yellow in dense spikes. The Acacias form a large genus of shrubs and trees found throughout the tropics and Australia ; a number of species are cultivated as ornamental street trees in California, prized for their delicate fern-like foliage and sunny yellow flowers. The small flowers are not like those of the Pea, being regular and small, clustered in a dense spherical head the size of a pea. Often these heads so completely cover the tree that no foliage is visible, the tree becoming a great mass of golden yellow. Some of the Acacias have compound leaves, such as the Common Acacia from Australia ; others lack leaves and have the leaf stems broadened and flattened to form leaf-like phyllodes, such as the Golden Wattle and the Willow Acacia, also from Australia. The Cat's Claw of Florida belongs to another genus (*Pithecolobium*) with similar globular heads of yellow flowers but compound leaves divided into apparently four large leaflets ; a related species grows in Texas.

Acacia-like plants from tropical America include the interesting Sensitive Plant (*Mimosa*). In this plant the leaflets fold together when touched ; or, if the contact is violent enough, the whole leaf bends downward due to changes taking place in a cushion of tissue at the base of the leaf stalk. Such a movement response on the part of a plant is known as a "tropism" ; in this case the tropism is in response to physical stimulation. Other tropisms of plants take place in response to a stimulus of light, of gravity, or of the presence of water.

CHAPTER XXI

The Rose Family



THE Rose Family (*Rosaceae*) vies with the Grasses for the honor of being the most valuable group of cultivated plants; in number of edible varieties it surpasses the Pea Family, though there are fewer (2,500) species. It is a family of wild and cultivated flowers, shrubs and trees which are widely distributed over the earth. The flower



ROSACEAE

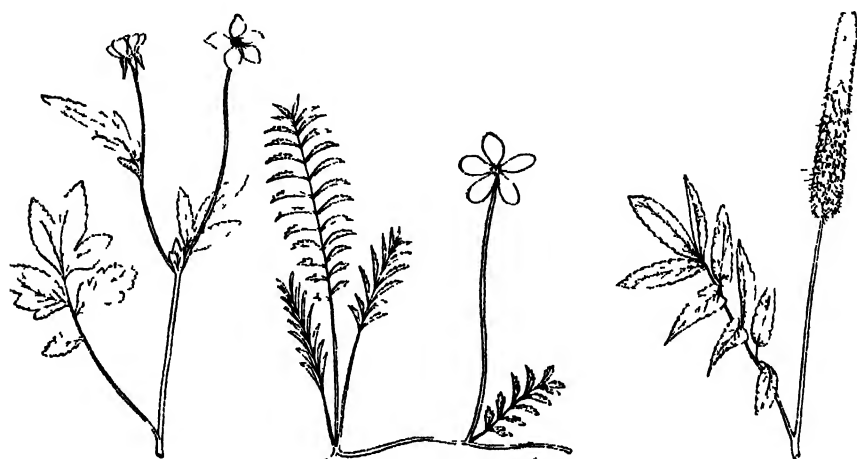
Five Finger, Marsh Cinquefoil, Bowman's Root.

is typically situated on a cup- or urn-shaped enlargement of the flowering stalk, to the rim of which are attached the five sepals, five petals and numerous rows of stamens. In many species the leaves are pinnately compound and the stems thorny or bristly.

The Rose Family includes numerous wild flowers which have no relatives of economic importance; Five Finger, Steeplebush, Meadowsweet, Indian Physic, Prairie Meadowsweet, Avens, Burnet, Agrimony, False Violet, Thimbleweed and Wild Rose. Some of these have ornamental garden varieties; Potentillas, Spiraeas, Bridal Wreath and Roses.

Then there are those flowering shrubs and trees which have fruits of little edible value, Cream Bush, Toyon, Chamise, Antelope Brush, Shad Bush, Nine Bark, Mountain Mahogany, Hawthorn and Mountain Ash

But the most important members of the family are those species, some of which are native to the United States, that can be cultivated for their edible fruits, Strawberry, Blackberry, Raspberry, Apple, Pear, Quince, Peach, Plum, Almond, Cherry, Apricot and Loquat



ROSACEAE

Yellow Aconit, Silverweed and Burnet

WILD FLOWERS OF THE FAMILY

The Five Fingers or Cinquefoils (*Potentilla*) are a large group of some three hundred species found everywhere in north temperate and sub-arctic regions, the majority of our native species, which number about forty, are western, with fewer representatives in eastern United States. The common name refers to the compound leaves, which in some species are made up of five leaflets arranged like the fingers of a hand, the scientific name comes from the Latin "potens" meaning powerful, in reference to the supposed medicinal powers of the plant. The flowers are usually yellow, a few are white or red. The common eastern Five Finger is a low-growing flower reproducing by runners, with yellow flowers in the axils of the five-parted leaves. It is a common flower of dry meadows and roadsides in all the states east of Minnesota and Texas. The Rough Cinquefoil is a tall leafy stemmed plant with three-parted leaves and light yellow flowers, thriving in waste places from New England to Florida, west to Kansas. The Yellow-flowered Silvery Cinquefoil common to dry barren fields of the central and eastern states is a naturalized European species, its compound leaves have palmately arranged leaflets, woolly white on their undersurface and a hairy white calyx. Shrubby Cinquefoil is a more northern species, found in the Pacific coast mountains and in the Northeast as far south as New Jersey, it grows to be a thickly branched shrub about four feet in height, with compound leaves and bright yellow



Meadowsweet (*Spiraea latifolia*) is a shrubby member of the Rose Family with clusters of rose-pink or white flowers. Brooksville, Maine.

flowers. The *Potentillas* of our gardens are for the most part varieties of European species. Silverweed (*Argentina*) is similar to the Cinquefoil in habit and in its pinnately compound leaves. The flowers, which appear in the axils of the leaves, have broad yellow petals. Silverweed grows in the northern tier of states from New England to the Pacific coast. Its name describes the appearance of the leaves, which have a silky white undersurface. Marsh Cinquefoil (*Comarum*) is the aquatic member of the family, growing in bogs from New Hampshire to California; its compound leaves have five to seven leaflets, and the reddish flowers have a purple calyx.



ROSACEAE

False Violet, Agrimony and Thimbleberry.

Meadowsweet and Steeplebush are two common species of the same genus (*Spiraea*): the individual flowers of the various members of this group are small, but they are bunched in flat-topped or cylindrical showy clusters. Seventy species are native to North America and Asia; most of ours are found from New England south to North Carolina and west to Nebraska. Each flower has five petals and five sepals inserted on a saucer-shaped receptacle with fifteen to twenty stamens lining the inner edge of the cup. Meadowsweet is a shrubby species growing in meadows and along roadsides; its rose-pink or white flowers form small clusters which often cover the entire bush. Steeplebush or Hardhack is a smaller plant which forms characteristic dense clumps in pastures and open woodlands; the graceful erect shoots are terminated by dense spikes of rose or purple flowers. Several members of the genus are found west of the Rocky Mountains; Douglas' *Spiraea*, with rose-pink flowers in rather narrow clusters, grows in the mountains from California to British Columbia. Many garden varieties have been introduced from China and Japan. Best known is the Bridal Wreath, native to Japan, with its arching branches covered with compact flat clusters of small white flowers.

American Ipecac or Indian Physic (*Porteranthus*) is a perennial with three-parted compound leaves, each leaflet long, narrow and toothed. There are leaf-like



The Wild Rose (*Rosa virginiana*) is one of the attractive wild flowers which adorn the roadsides of our eastern states. Brooksville, Maine.

blades (known as stipules) growing at the base of the leaf stalks. The white or pink flowers have narrow petals and are produced in loose, open clusters. Indian Physic grows in woods and thickets west of the Blue Ridge Mountains to Kansas. A closely related species, Bowman's Root, found from New York to Georgia and Michigan, lacks the stipules.

Prairie Meadowsweet or Queen of the Prairie (*Filipendula*) has palmately lobed leaves and pink or purple flowers with broad petals and conspicuous stamens, it is partial to moist ground and swamps from New England to Georgia and Iowa.

Avens (*Geum*) is a plant mostly of the eastern and central states, it has com-



ROSACEAE

Lyon, Greasewood and Wild Strawberry

pound leaves with three to nine leaflets and usually yellow (sometimes white or purple) flowers in terminal clusters. Yellow Avens grows in wet and shaded places of the northeastern states and on the Pacific coast, it is sparingly branched with flowers in small terminal clusters. Water Avens is a purple-flowering species of bogs and meadows in northeastern United States, the nodding flowers have a purplish calyx and less conspicuous reddish-orange petals which are narrowed at the base. Old Man's Whiskers, of the north central and western states, has dull red or purple flowers but conspicuous fruits, whose plume-like tails project in a hairy mass.

Burnet (*Sanguisorba*) is an erect plant with pinnately compound leaves and dense spikes of greenish white flowers which are unusual in that they lack petals, the four sepals being white and petal-like. Burnet grows in swamps and low meadows, from New England to Georgia and Michigan. Supposed styptic properties of the sap is responsible for the scientific name which means "blood absorbing." European species are grown as condiment plants in herb gardens, because of their value in flavoring soups and salads. There are two related species on the Pacific coast.

Agrimony (*Agrimonia*) has unusual compound leaves, with smaller leaflets interposed between the larger ones, the flowers are yellow and borne in loose clusters.



The Hawthorn (*Crataegus*) blossoms are well protected amid long-spined branches. Hamilton, New York.

It is common along roadsides and in woods throughout all the eastern and central states.

Dewdrop or False Violet (*Dalibarda*) is one of the few flowers of the Rose Family with simple heart shaped leaves, it is a low creeping plant of northeastern woodlands with two kinds of flowers—conspicuous, usually sterile ones with white petals, and smaller fertile flowers lacking petals.

More shrubby than most of the preceding species is the Thimbleberry or Flower-



ROSACEAE (*Rosa*)

Cherokee Rose (upper left), Tea Rose (lower left), Prairie Rose (upper right), Rambler (lower right)

ing Raspberry (*Rubus*) of the eastern and central states, it has simple maple-like leaves and large showy white, pink or purple flowers. Thimbleberry prefers rocky woods and thickets, where it flowers and produces fruits which are not palatable.

Goat's Beard (*Aruncus*) is a Eurasian flower which has become naturalized in the eastern states, and is sometimes found as a garden ornamental. It is a rather large plant with pinnately compound leaves and open clusters of flowers with broad white petals and protruding stamens.

There are at least a hundred different species of Roses (*Rosa*) distributed throughout the Northern Hemisphere, with a thousand or more cultivated varieties. Roses are preeminently plants of open sunny yet sheltered places such as are common in the grasslands of our central states, where over twenty-five native species are known;



Chokecherry (*Prunus virginiana*) trees have clusters of white flowers which often are far more attractive than the bitter fruits. Hamilton, New York.

Rambler Rose of many porches and trellises comes from white and pink flowering climbers native to China and Japan. Tea Roses are evergreen or deciduous shrubs with flowers of white, pink, salmon and yellow tints; the large double-flowered varieties were introduced into England from west China over a hundred years ago. Also from China comes the white and yellow flowering Banks' Rose, a vigorous climber. One plant bears the distinction of having grown to be the largest rose tree in the United States. With a central trunk almost a foot in diameter and a spreading crown, it roofs over an entire courtyard in historic Tombstone, Arizona. The China or Bengal Rose is a low shrub with three- to five-parted compound leaves and red or pink



ROSACEAE

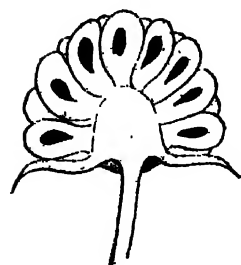
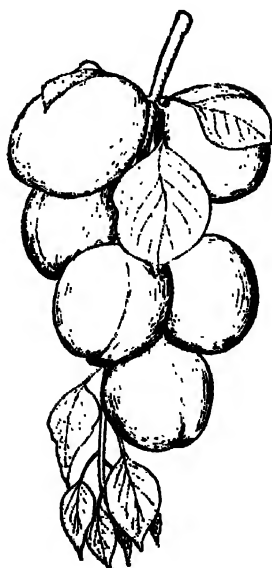
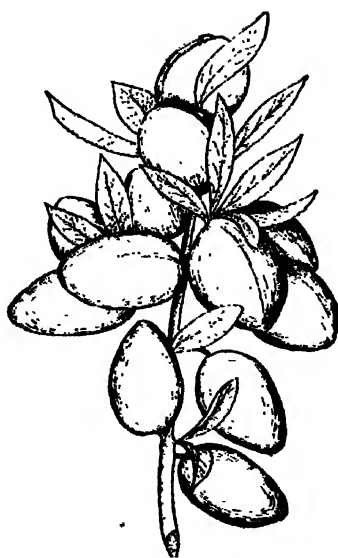
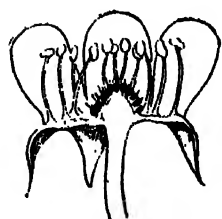
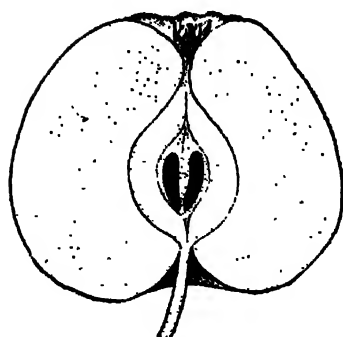
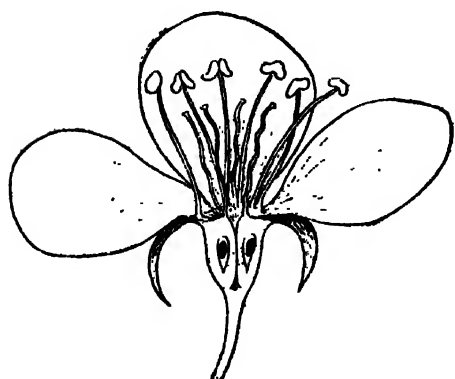
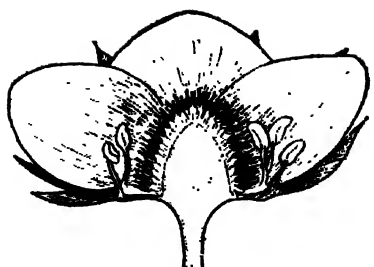
Flowering Raspberry, Wild Red Raspberry, Blackberry.

flowers; from this have been derived such varieties as the dwarf Fairy Roses and the green petaled Green Roses. A familiar variety is the sturdy climbing Cherokee Rose native to China and Japan; the large white flowers are single, and often three inches in diameter. It is one of the few garden roses which has become naturalized in the United States, especially along the coastal plain.

FLOWERING SHRUBS AND TREES

Shad Bush or Serviceberry (*Amelanchier*) is a widely distributed American tree and shrub, with related species found in the Mediterranean region and eastern Asia. The small simple leaves are oval in shape; in early spring the branches are covered with clusters of small white flowers, and in late summer with spherical bluish-purple fruits which are often covered with a light bloom.

The Hawthorns (*Crataegus*) are a large genus of over five hundred species, most of them North American. They are small thorny trees with simple leaves and showy white or pink blossoms; the red fruits resemble little apples, or large rose-hips. Most of them are eastern and southern in their range, a dozen or so venturing west to the prairie region and one west of the Rocky Mountains—the Western Black Haw with blue-black fruit



ROSACEAE

Representative Fruits of the Family.

Upper Row: Strawberry flower and fruit. *Second Row:* Apple flower and fruit. *Lower Row:* Raspberry flower and fruit (*left*), Almond (*center*), and Apricot (*right*).

One of the most handsome deciduous trees is the Mountain Ash (*Sorbus*) with its delicate pinnately compound leaves and large flat-topped clusters of small white flowers; in autumn the tree is strikingly colorful with drooping clusters of orange-red fruits. The eastern Mountain Ash grows in New England and westward, southward in the mountains to Pennsylvania and Tennessee; it reaches its greatest size around the Great Lakes. The western Mountain Ash grows along stream beds at altitudes varying from seven to nine thousand feet, from California to Alaska.

Nine Bark (*Physocarpa*) is a shrub with bark which strips off in many shreddy layers; a species common to the northeastern states grows along rocky stream mar-



ROSACEAE

Pear (*left*) and Quince, flower and fruit.

gins. The rounded or heart-shaped entire leaves are often three-lobed, and the white or pink blossoms are in terminal clusters much like a Spiraea.

Mountain Mahogany (*Cercocarpus*) is a shrubby evergreen tree with very hard wood, restricted to the dry interior and mountainous regions of the United States. The fruits have long hairy tails, giving the general appearance of a little shuttle with its thread trailing behind; hence the scientific name coming from "kerkis" meaning shuttle and "karpos" meaning fruit. Several species are found only on the islands off the California coast. Most widely distributed is Desert Mahogany with narrow entire leaves and small flowers with long silky tails to the fruits. This species is found on arid slopes from the Pacific coast to Colorado and Wyoming.

Four shrubby members of the Rose Family are restricted to the Pacific coast and adjoining regions. Cream Bush or Ocean Spray (*Holodiscus*) is a small shrub with entire, lobed-leaves and small creamy-white flowers in spreading terminal clusters. It is a plant of mountain canyons from California to Washington. California Holly or Toyon (*Photinia*) is an attractive flowering shrub of the California foothills with leathery elliptical leaves and small white flowers which give rise to bright orange-red fruits in autumn—the California substitute for the eastern true Holly. Greasewood or Chamise (*Adenostoma*) is another shrub of dry ridges and mesas of the California mountains; the small, linear and heath-like leaves are sweet smelling and grouped in small clusters. Small white flowers are crowded in dense terminal masses.

Another California species with shreddy red bark is known as Redshank. Antelope Brush (*Purshia*) is found in all the Pacific coast states but is especially common in the ranges bordering the Mojave Desert. The leaves are three-lobed, often in small clusters on the stem; the flowers are pale yellow or white.

MEMBERS OF THE ROSE FAMILY WITH EDIBLE FRUITS

Strawberry (*Fragaria*) includes about thirty-five species of stemless low-growing plants of the north temperate zone. The three-parted compound leaves are basal and from the creeping rootstock erect stems bear the large white five-petaled flowers. The



ROSACEAE

Loquat and Crab Apple.

fruit is in reality an enlarged and fleshy portion of the flowering stalk (the receptacle) in the surface of which the true fruits are buried as small brown specks. The common Wild or Virginia Strawberry is a plant of open sunny fields from New England to Minnesota and Oklahoma. The common name may have originated from "stray berry" in reference to the habit of reproducing by runners so that clumps of berry-forming plants appear at scattered intervals. The scientific name refers to the sweet odor of the plant. The cultivation of the Strawberry for its edible fruit began only in the last century, and in the United States this species was at first used for the purpose. Our present cultivated Strawberries are the descendants of the western Sand Strawberry, found from Alaska to Chile. The Wood Strawberry of the eastern and central states has narrow, conical fruit which is of little comestible value. The Baren or Dry Strawberry (*Haldsteinia*) is a creeping plant, much like the true Strawberry, with yellow flowers; it grows in rocky woods from New England to Minnesota and Oregon.

The Raspberries and Blackberries (*Rubus*) are species of the same genus, differentiated chiefly by a fruit peculiarity; in the Raspberries the cluster of little fleshy fruits separate in a thimble-shaped mass from the flower stalk or receptacle, while in the Blackberries the fruit cluster remains attached to the receptacle. They are shrubby climbing plants usually with compound leaves and prickly stems which are

known as "canes". The genus is a large one, with about four hundred species, most of which are found in Europe and North America, a few in China, Japan and the tropics. The scientific name, of Latin origin, undoubtedly is connected with "rubber" meaning red, applied to the color of the juice of the fruits. Three common native American Raspberries are the Thimbleberry or Black Raspberry of the eastern and central states, with bluish-purple fruits; the American Red Raspberry, of the same range, with light red fruits and commonly cultivated as one of the hardy native edible plants; and the Western Red Raspberry native to the mountain slopes from California to Washington and Wyoming. The European Raspberry, sometimes found in cultivation, yields white and yellow as well as red fruits. Some of the species are grown as garden flowers. The Rocky Mountain Flowering Raspberry is a compact bush with pure white rose-like flowers; it is native to the mountain canyons of Colorado. The Eastern Flowering Raspberry, of woods from Nova Scotia to Alabama and Michigan, is also used ornamentally because of its large rose-purple flowers. The garden varieties of Blackberries are thought to be derived from two common Wild Blackberries of northeastern United States. There is a Western Blackberry native to the southern Pacific coast. The so-called Oregon Everbearing Blackberry, commonly cultivated in the northwest, is a European species. The Dewberries are other American members of the genus which are sometimes cultivated; they are low-growing plants with trailing prickly stems and blackberry-like fruit. The Loganberry is a hybrid developed by chance from crossing a California Dewberry with the European Raspberry; it is a rather tender plant with dark evergreen foliage, grown chiefly in Oregon. The Loganberry is named after Judge Logan of Santa Cruz, California, who produced the new fruit in 1881. Another valuable cross is the Primm Berry, secured by Luther Burbank in crossing a blackberry and a raspberry.

The Apple (*Malus*) includes about twenty species from North America, Europe and Asia. Our native representatives of the genus, with simple leaves and pinkish-white blossoms, are small trees known as Crab Apples. The edible portion of the apple is in reality a greatly enlarged receptacle which increases in size, surrounding the seeds which are inside the pithy core of the receptacle. One of the widely distributed Eastern Crab Apples grows from New York south to Alabama and west to Ohio; its fruit is yellowish-green at maturity. Most of the Crab Apple species center in the Appalachian region; only one grows on the Pacific coast—the Oregon Crab Apple, with fruit which becomes purplish in color with age. The cultivated apple is descended chiefly from the European Apple, considered native to Europe and western Asia. Apples have been cultivated for the past three thousand years, and were the first fruits introduced into Great Britain by the Romans. Charred remains of apples are found among the ruins of the Swiss Lake Dwellers. They are preeminently cool region fruits, being grown farther north than cherries, peaches or pears; apples are the typically American fruit, crops for local consumption being grown in almost every state. A third of all the apples raised in the United States are grown in New England, New York and Pennsylvania. In the mid-central corn belt apples are the chief fruit crop, grown in only slightly less amount than in the northeastern states. The remaining American apples come from Oregon and Washington. A considerable quantity of our apples are shipped to Europe, where they are considered superior to the native apples. Apple juice, as cider, is the favorite autumnal beverage. When yeast plants

bring about fermentation of the cider, changing the sugary apple juice to alcohol and carbon dioxide, hard cider results; this is also the first step in making vinegar. Hard cider is changed to vinegar by continued fermentation, this time by acetic acid bacteria.

There are almost a thousand varieties of apples, the result of years of experimental crossing of a few native and foreign species. Many of the varieties were the result of chance hybridization in nature. One of the oldest varieties is the McIntosh, named after John McIntosh who settled at Dundela, Ontario, in 1796. Here he cultivated a



ROSACEAE

European Cherry, flower and fruit (*left*); Sierra Plum (*upper right*), Wild Black Cherry (*lower right*).

small grove of native wild apple trees. The fruit was so delicious that twigs and buds were given to other farmers for grafting, thus increasing the number of trees bearing this prized eastern apple; one of the original trees was still standing over a century later, in 1908. The Northern Spy Apple originated about 1800 in an orchard in Bloomfield, New York; and in another New York orchard at Camillus farmer Calvin Bingham produced the Primate Apple about 1840. The Baldwin Apple was discovered near Lowell, Massachusetts in 1793 by a surveyor who was laying out the Middlesex Canal. One of the leading apples of the upper Mississippi Valley is the Wealthy; this was originated by Peter Gideon at Excelsior, Minnesota in 1894.

Pears (*Pyrus*) are closely related to apples; they have simple leaves, showy white blossoms and an elongated fruit which is an enlarged fleshy portion of the receptacle. There are no native species, all the Pears having originated in southern Europe and

Asia. These, crossed with the Oriental Pear, yield most of our cultivated varieties. Pears were introduced early into the New England states, and thrive well as far west as the Great Lakes; they are also grown on the Pacific coast. There are not as many varieties as of apples; the Bartlett is the best known. Two other varieties are the LeConte which appeared in 1850 and was introduced into the southern states after the Civil War, and the Kieffer, originated by an Alsatian gardener of that name in Philadelphia about 1870.

The Quince (*Cydonia*) is a small tree from central and eastern Asia with white or pink flowers and a yellow fruit shaped somewhat like apples or pears. Though the fruit was popular with the ancients and is repeatedly mentioned in the classical literature, it is not a commonly used fruit in the United States. Most Quince trees grow in neglect in backyards and around farmhouses, their fruit used chiefly for making jellies.

The Loquat (*Eriobotrya*) is a little known fruit of the Rose Family, produced on a small evergreen tree native to China and Japan. It is grown around homes in Florida and the Gulf States, much as the Quince is farther north. Loquats are grown commercially in some parts of California. The small white flowers are very fragrant. The spherical or pear-shaped fruits, averaging two or three inches in length, have a yellowish tough skin; the salmon-colored flesh, surrounding a few large brown seeds, has a cherry flavor.

The Cherries, Plums, Peaches and related fruits are all species of the same genus (*Prunus*). They can be recognized by a hard casing, which in turn is embedded in the fleshy and often edible part of the fruit. There are about 175 species; mostly north temperate in distribution; about twenty occur in the United States.

Cherry trees have reddish-brown to black bark which is often marked with elongated lenticels, reminding one of the similar trunk markings of the Birches. There are three common Pacific coast species of *Prunus*. The Hollyleaf Cherry, an evergreen with white flowers and dark purple fruit in small clusters, grows along stream margins and in wet sandy soil on the California coast ranges; the flesh, though thin, is sweet. The Western Chokecherry is a shrubby tree with red or purple fruit in large clusters; it grows on mountain slopes from California to Washington. The Sierra Plum has two to four red fruits in a cluster, and is found in canyons along the entire Pacific coast. The common species east of the Rocky Mountains include the Chokecherry, Wild Black Cherry and Wild Red Cherry. The Chokecherry is a widely distributed medium-sized tree or shrub of valleys and mountain slopes from New England to Florida, west to Texas and North Dakota; the white flowers are in drooping clusters, forming fruits which change from bright red to a purplish-black at maturity. The Wild Black Cherry or Rum Cherry is of the same range; it becomes a large tree often a hundred feet high, bearing flowers and dark red fruits in small clusters. The bark is a source of hydrocyanic acid and has medicinal properties; while the rich red wood is often used for cabinet work and was once popular as an interior finish. The Pin Cherry or Wild Red Cherry grows to only half the height of the preceding species; it is found in rocky woods and clearings from New England to Georgia and the Dakotas. This Cherry has creamy-white flowers in small clusters; the fruit is red and sour. Cultivated Cherries are varieties derived from the European Sweet Cherry or the Sour Cherry. The Sweet Cherry, native to Asia Minor and

Europe, was cultivated in the latter country before the Christian Era. The Sour Cherry, a smaller and hardier tree, is also a native of Asia Minor. There are some five hundred varieties of these two species. The majority of cherries grown for cooking and canning are the sour red types. Cherries are a crop of commercial importance in New York, Michigan, Wisconsin, Colorado and California. Cherry trees are also grown for their ornamental blossoms, being especially prized for this purpose in Japan. The Japanese Cherry trees of Washington, D. C. are representative of the possible ornamental value of these trees.

There are several native species of Wild Plums. The Chickasaw Plum or Sand Plum is a tree of the coastal plain region, with creamy-white flowers in small clusters of two to four, producing medium-sized red or yellow fruits. Another plum of the same range, with similar fruit and flowers, is the Black Sloe Plum. The American Wild Plum is a medium-sized tree found in rich soil from New York to Florida, west to Colorado; its bright red fruit grows to be almost an inch in diameter and occurs in small clusters of two to four plums. The Canada Plum of the northeastern and north central states is a tree with more elongated red fruit. The older varieties of Garden Plums were derived from the European Plum, native to the Caucasus region; they include the Green Gage and Lombard varieties which are grown chiefly on the Pacific coast and the Great Lakes region. The Cherry Plum, native to southeastern Europe and adjacent Asia has given us other varieties such as the Golden Cherry and the Marianna. Many of the most desirable Plum hybrids were originated by Luther Burbank from the Japanese Plum; two of these are the well-known Satsuma and Burbank Plums. Other varieties, secured by using our native Wild Plum, Canada Plum and Chickasaw Plum as one of the parents to the cross, are more hardy. There are now about three hundred different kinds of plums, many of them with native American sap in their veins.

Many of the plums grown in California are cured, dried, and marketed as prunes; these are the second ranking deciduous tree crop of the state, the peach taking first place. Any plum with a high percentage of sugar, capable of being cured without removing the stone, makes a good prune; most of them are varieties of the European Plum. Fruits are gathered only after having dropped to the ground; the plums are then gathered, dipped in boiling water or lye, and allowed to dry in racks in the sun; before shipping they are given a glossy coating by treatment with glycerine, fruit juice or boiling salt water. The Apricot (another species of *Prunus*), a native of eastern Asia, is known to have been cultivated in China by at least two thousand B.C. Its use spread to Europe by way of India, Persia and Armenia; and is now cultivated in warm temperate climates everywhere. The fruit is intermediate between a peach and a plum in color and shape, but with a smoother skin than a peach and a smooth flat stone. The Apricot was introduced to California by the Spanish padres late in the eighteenth century; the trees grew so well in the California climate that within recent years apricot growing has become one of the leading interests of the state, over forty thousand acres being devoted to raising this fruit. Most of the apricots are produced in the Santa Clara and other interior valleys, where the bulk of the prune crop, also, is grown. Most of the apricots are dried or canned for commercial purposes. A Japanese Apricot, similar in general appearance to the ornamental Cherries, is grown for its showy blossoms.

The Peach is a species of the genus, native to China and introduced to Europe about 500 B.C. Peach trees were brought to Mexico by the early Spaniards, and from there came into the United States. The best known variety is the Elberta, showing characteristics of the Chinese Peach and of a Persian variety. Though peaches are grown in almost every state, they are an important fruit crop only in Michigan, Georgia and California. The great peach growing sections of California are in the San Joaquin and Sacramento valleys. Ornamental varieties are grown for their white, pink or red showy blossoms.

Since Almond trees flower before the leaves appear, the branches are conspicuously covered with masses of large pink flowers. The fruit is somewhat like a peach in structure, the almond of commerce being comparable to the peach stone. Almonds are native to the Mediterranean region, the chief almond producing centers today being Italy and Spain; in this country, they are grown in California, where there are some twenty-five varieties under cultivation. Like the other members of the genus, some species are cultivated as blossoming shrubs and trees because of their attractive flowers.

CHAPTER XX

The Cacti



OUR supply of adjectives is inadequate to describe the variety of shapes and the diversified appeal of the members of the Cactus Family (*Cactaceae*). They have been variously noted as fantastic, bizarre, weird, marvellous, grotesque, astounding and fascinating. They are all of these and much more. Whether one is acquainted with them only in the window dish garden of a New England home, in some outdoor cactus garden of an estate in the Southwest, or in their native home on a gravelly mesa, in a rocky canyon or sandy desert of one of our southwestern states, he soon discovers that these plants are strikingly different from the rest of the plant kingdom.

The family includes some thousand species of trees, shrubs, vines and low-growing plants occupying a great variety of habitats. Cacti are heroic plants, commanding our respect because they have solved the problem of living on that frontier of the habitable world where life is a most precarious venture. There the merciless heat of the broiling sun beats down upon them; there the scarcity of water, so absolutely essential for living protoplasm, confronts them. To conserve what little water they can absorb during the few rainy days of the year, most Cacti have evolved leafless bodies—dispensing with leaves because their tiny breathing pores would lose, through evaporation, the precious water from the plant bodies. The green or gray stems have taken over the business of photosynthesis. In addition, special precautions have been taken for storing the water; hence Cacti have thick succulent stems of which 98% of the weight is water. Even the surface of the stem is reduced to the minimum, most of the members of the family being unbranched cylindrical or hemispherical plants. Some of the Cacti have enlarged tuberous roots for the storage of water. Thus the succulent leafless stems of the Cactus Family are really the badge of a group of plants which has dared to live in a decidedly unfavorable environment.

This very adaptation, however, brought with it attendant dangers. Succulent and juicy herbage is rare on the desert and in the arid mountains; so, with the appearance of these plants, a host of animals immediately found them suitable food. Somewhere in the evolution of the Cacti, modified stems in the form of spines appeared; these spiny species were severely let alone by the animals. Gradually these spined forms survived and increased in numbers so that today the Cactus Family is predominantly made up of spiny, bristly and thorny plants. An attempt by Luther Burbank and others to breed out the spines which Nature took millions of years to produce has

met with but little success ; a spineless race of Cacti would be a boon to cattle men on the more arid prairie lands where Cactus alone will thrive. These spines are resinous and enduring structures, needle sharp ; spines have been known to persist unchanged on the trunk of giant Suaharos several centuries old. They remain on the ground long after other parts of the cactus plant have rotted away. Often the spines are beautifully colored and variegated in shades of red, pink, orange, brown, yellow and purple as well as white. There has been much speculation as to the value of spines. Since, as a rule, the spiniest Cacti grow in the hottest regions (in several cases where the temperature reaches 150 degrees), it is possible that the interfacing spines cut off some of the intense light and raise the humidity within the network of thorns, thus reducing whatever evaporation of water there might be. The spines, the rudimentary



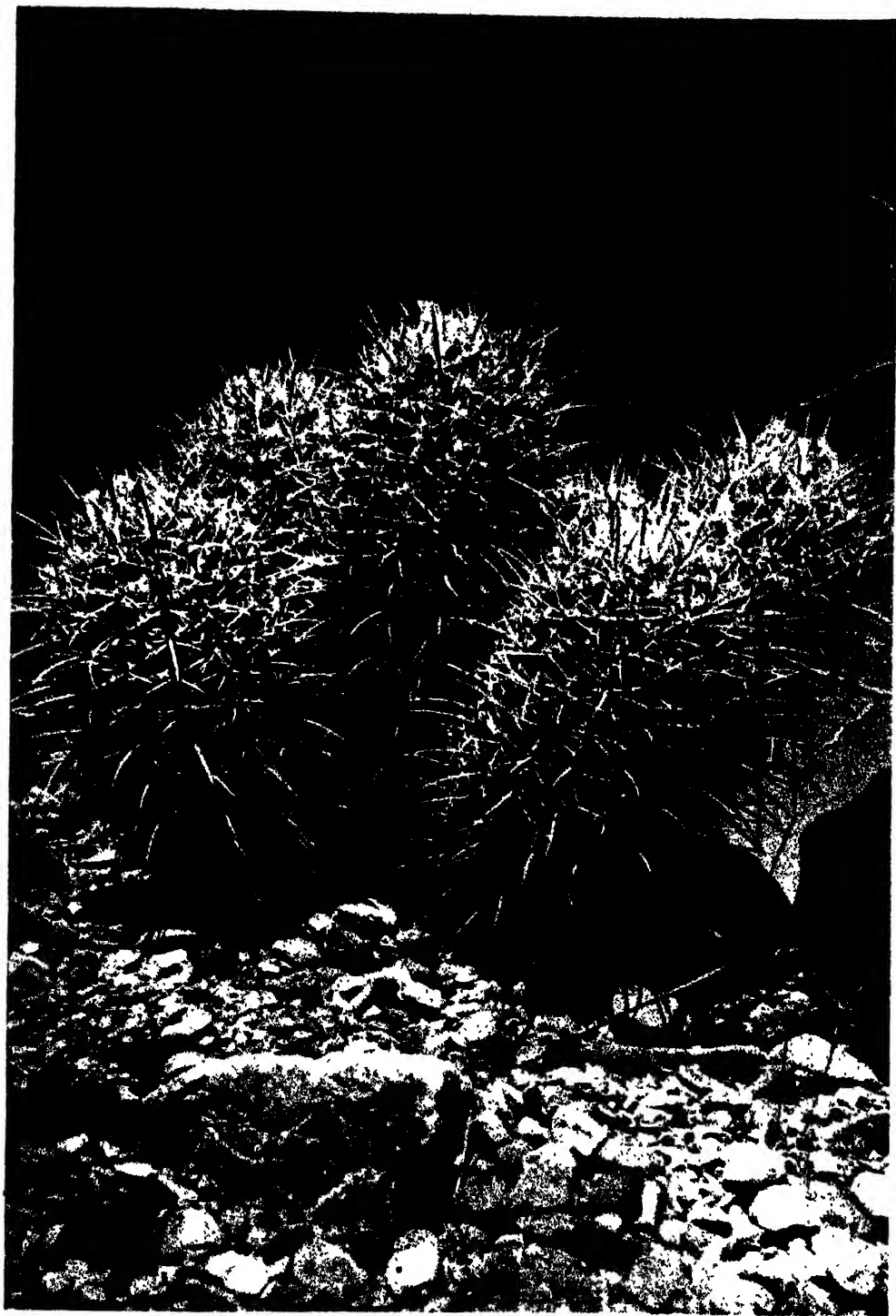
CACTACEAE

Barbados Gooseberry.

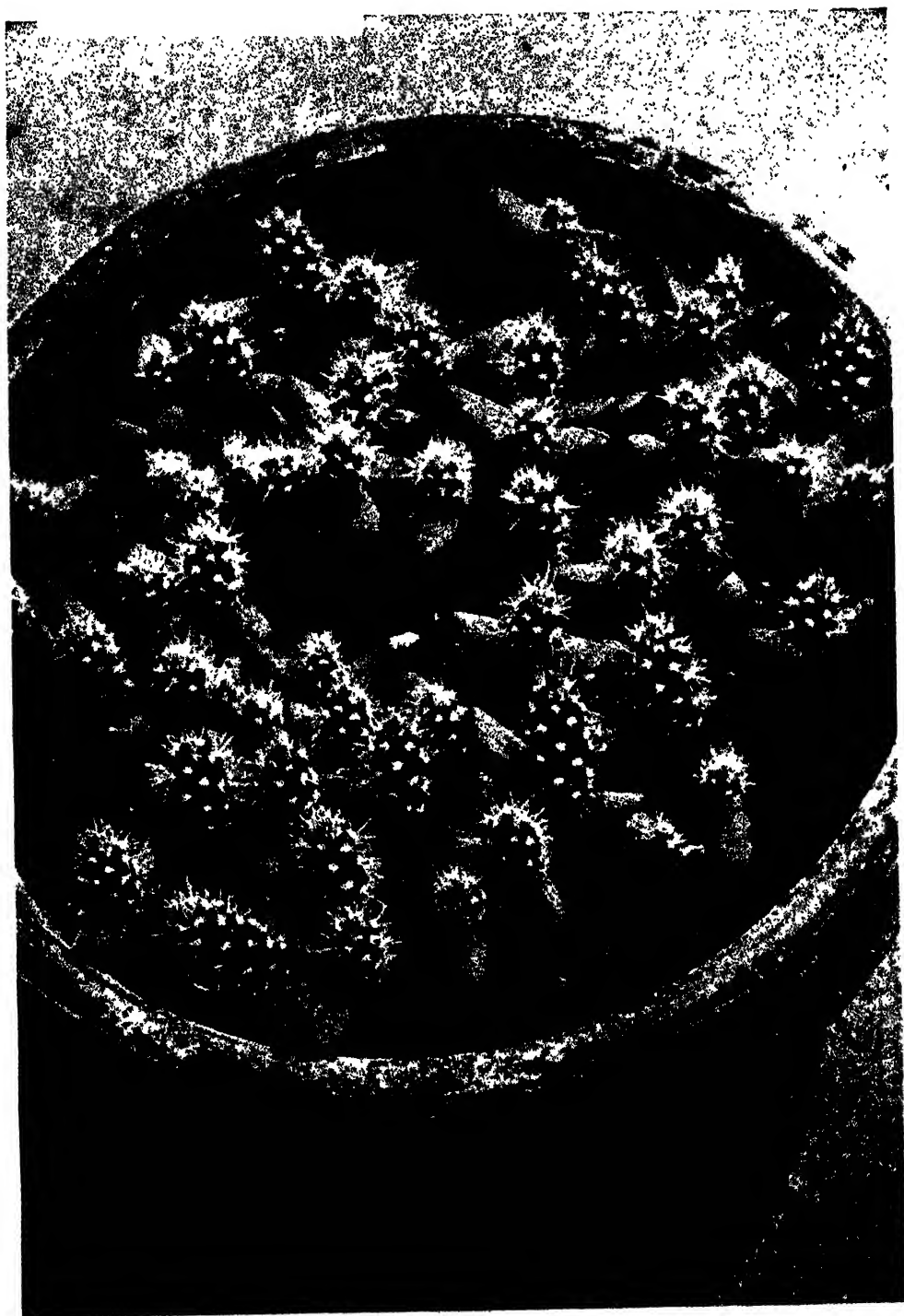
leaves and flower buds all appear in special areas of the stem known as "areoles" which are openings in the otherwise cuticle-encased stem.

A surprising characteristic of the Cacti is that plants so grotesque and misshapen can produce such exquisite flowers. For eleven months these thorny barrels and spiny spheres cling inconspicuously to the desert mountain slopes. Then comes springtime, and for a short period the Cacti bloom with such colorful flowers as are found nowhere else in all the plant world. Some of the blossoms are six inches in diameter, and twice that in length ; many are broadly cup-shaped, others funnel-shaped ; most have numerous sepals grading in color into the brilliantly scarlet, purple, yellow or snowy-white petals. Inside, is a golden tangle of stamens—three thousand of them in the Suaharo flower. These blossoms are all notably sensitive to light ; some bloom for only a few hours, or a single day ; others open only at night, spreading their fragrance into the desert air. This is the case with the various Night Blooming Cereus Cacti. These justly famed flowers are well described as follows.

"You must come to the desert in the soft shadows of the moonlit night to see the ethereal beauty of this rare and exquisite flower. For only one night in each year does the *Cereus Greggii* come forth into bloom, scenting the warm sweet air of the



California Barrel Cactus (*Echinocactus acanthodes*) growing amid the stony ridges on the floor of Death Valley, California.



Two month old cactus seedlings (*Opuntia*) showing the spineless cotyledons, or seed leaves. New York Botanical Garden.



The Sahuaro Cactus (*Cercus giganteus*) is the largest and most spectacular of the Cactus Family, its fluted columns rising thirty and forty feet into the air. Sahuaro National Forest, Tucson, Arizona.

tral America and South America ; they are relatively rare in the United States, only a few being found in Florida, Texas, Arizona, New Mexico and California.

Largest and most spectacular of the whole Cactus Family is the Sahuaro --the Sage of the Desert. This giant is a massive columnar plant with twenty to twenty-five lengthwise ridges or ribs and corresponding furrows between them. This is really a clever engineering device, for the ridges and grooves are elastic and make possible a variable diameter to the plant. As the storage tissues of the cactus fill up with water after the rare rains, the stem increases in diameter and becomes plump and taut with the ridges far apart. But after a prolonged thirst--these plants can live for three years without a drop of water--the storage tissues shrink, the ridges move closer together and the Sahuaro becomes a wrinkled image of its former self. Sahuaros grow slowly, taking fifty years to reach a height of fifteen feet ; five and eight year old seedlings are only a few inches tall. There are many Sahuaros thirty and forty feet in height, which must be at least two hundred years old. The base of these desert veterans, several feet in diameter, is covered with spineless gray patches of bark. To support this massive body, the Sahuaro has a woody skeleton of bamboo-like rods running lengthwise beneath the surface of the plant ; they form a hollow cylinder with the watery tissues within and outside of it. Hawks build their nests in the forks where two or three branches leave the main trunk ; woodpeckers and owls make their homes in holes in the fluted stems, safe from intruders in this spiny fortress of the desert. The flowers, about four inches long and two inches wide, are produced at the tops of the stems ; they are waxy white, with the throat of the blossom filled with thousands of stamens surrounding the central pistil. Each flower blooms for a night only, closing by the following forenoon. Appropriately enough, the Sahuaro blossom is the state flower of Arizona. These remarkable tree cacti are most abundant on the rocky slopes and mesas of the Arizona mountains, being rare in the flat lowlands ; they are confined almost exclusively to that state, a few areas existing in the Colorado River region of California and in Mexico. Fortunately they are preserved in the Sahuaro National Forest, near Tucson, where the rocky slopes are covered with a fine forest of these unique trees, their clusters of upward reaching branches like candelabras or torches ; here square miles are populated with the graceful green columns, towering over the undergrowth of Many-colored Tree Cholla, Barrel Cactus, Prickly Pear and Palo Verdes.

Next in size to the Sahuaro is the Pipe Organ Cactus or Pitaya of extreme southern Arizona and Mexico, one of the rarest of our native cacti. It looks like a slender Sahuaro, branching however at the ground to form a dense mass of erect cylindrical stems six to eight inches in diameter, ten to twenty feet high. The dozen or more lengthwise ribs, with their spine clusters, give a pleated appearance to the plant. Pipe Organ Cactus is the aristocrat of the arid rocky mesas, where--like so many of the genus--it opens its flowers to the desert night. Indians and Mexicans make jellies, candies and wines from the olive-green fruits.

Another species of *Cercus* rarely seen except as very young and small individuals in cactus collections is the Old Man Cactus. This is a columnar unbranched plant of inaccessible rocky hillsides of northern Mexico, where it often grows to a height of thirty feet. The long spines are intermingled with a tawny gray wool or hair, the stringy mass sometimes twelve inches in length, and all contributing to give the



Organ Pipe Cactus (*Cylindropuntia thurberi*), one of our rarest native Cacti, is the aristocrat of rocky, arid mesas. Huntington Botanical Garden, San Marino, California.

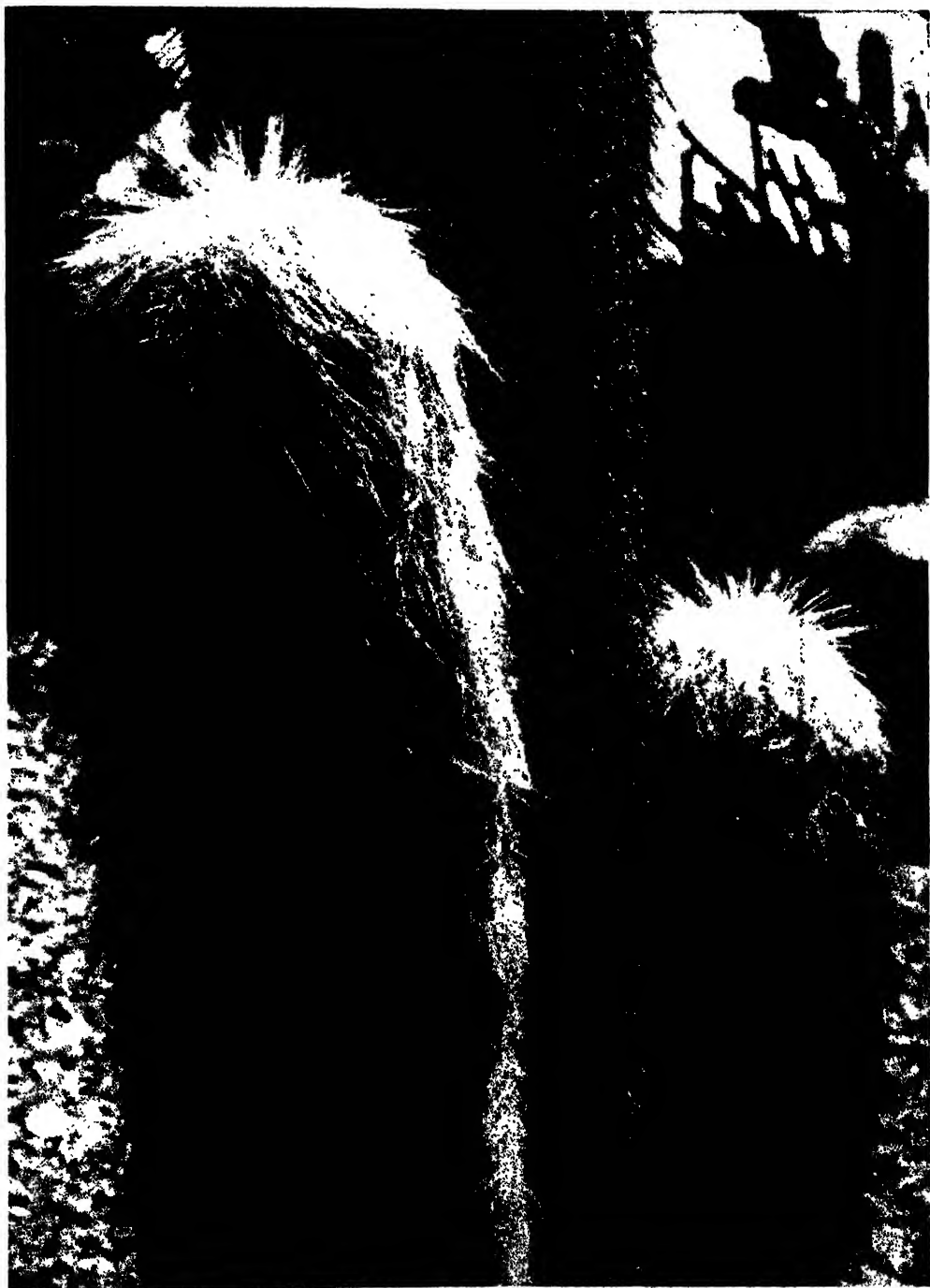
cactus a hirsute appearance like that of some old gray-bearded and long-haired "desert rat".

Many of the *Cereus* species are known as Night-blooming Cerei, prized for their rare and fragrant flowers. "La Reina de Noche" of Mexico forms a prostrate mass of entangled stems, each with rounded lengthwise ribs with their clusters of spines at regular intervals. This cactus is a common climber, covering walls, hedges and bushes of eastern Mexico with sinuous stems. The rather repulsive looking plant makes up for its appearance one night every year, when the buds burst forth into large creamy-white or pink flowers twelve inches long and seven inches in diameter, with a "corona of stamens which are a symphony of pale yellow and white"; the perfume from a single blossom fills a large area with its fragrance. The Night-blooming *Cereus* of our Southwest, because of the dull gray-green color of the slender stems, looks like a mass of dead sticks; the apparently lifeless stems are four- or five-angled and covered with very short spines an eighth of an inch in length. The plants grow in clumps, often under the protection of a Creosote Bush or a Cat's Claw. As if to deliberately surprise mankind, this drab, inconspicuous cactus dazzles the world with a night-blooming white flower six inches in length and three inches in width. In the vicinity of Tucson the flowering date is approximately June 15, when the fragrance of these desert flowers is a guide to their location. Related night-blooming species are found in the Okeelobee Swamp of Florida. The best known cultivated Night-blooming *Cereus* is a plant with three-angled creeping stems which climbs over trees and walls. This has been under cultivation, especially in China, for so many centuries that the wild form is unknown; undoubtedly it came from tropical America. About Punalou College in Honolulu there is a wall completely covered by this *Cereus* half a mile long, producing five thousand flowers in a single night! Introduced into Florida during the Seminole War, it is now naturalized in the hammocks and on the Keys. The awkward, angular stems twist about tree trunks like some gray-brown snake—a marked contrast to the ethereal beauty of the fragrant waxy-white flowers.

OTHER CACTI

The animal kingdom is plentifully supplied with species which exemplify the value of protective coloration. But among plants, we seldom think of this adaptive feature as being of any importance. However, the Living Rock Cactus which ranges from Mexico into southern Texas is a perfect example of a protectively colored plant. The curious little cactus consists of a short rounded stem covered with spineless dark gray warty and triangular projections; in color and shape it looks as if it were carved out of the stones in the midst of which it is growing. What a surprise to find beautiful white, pink or purple flowers growing out of what at first sight seemed to be a piece of rock!

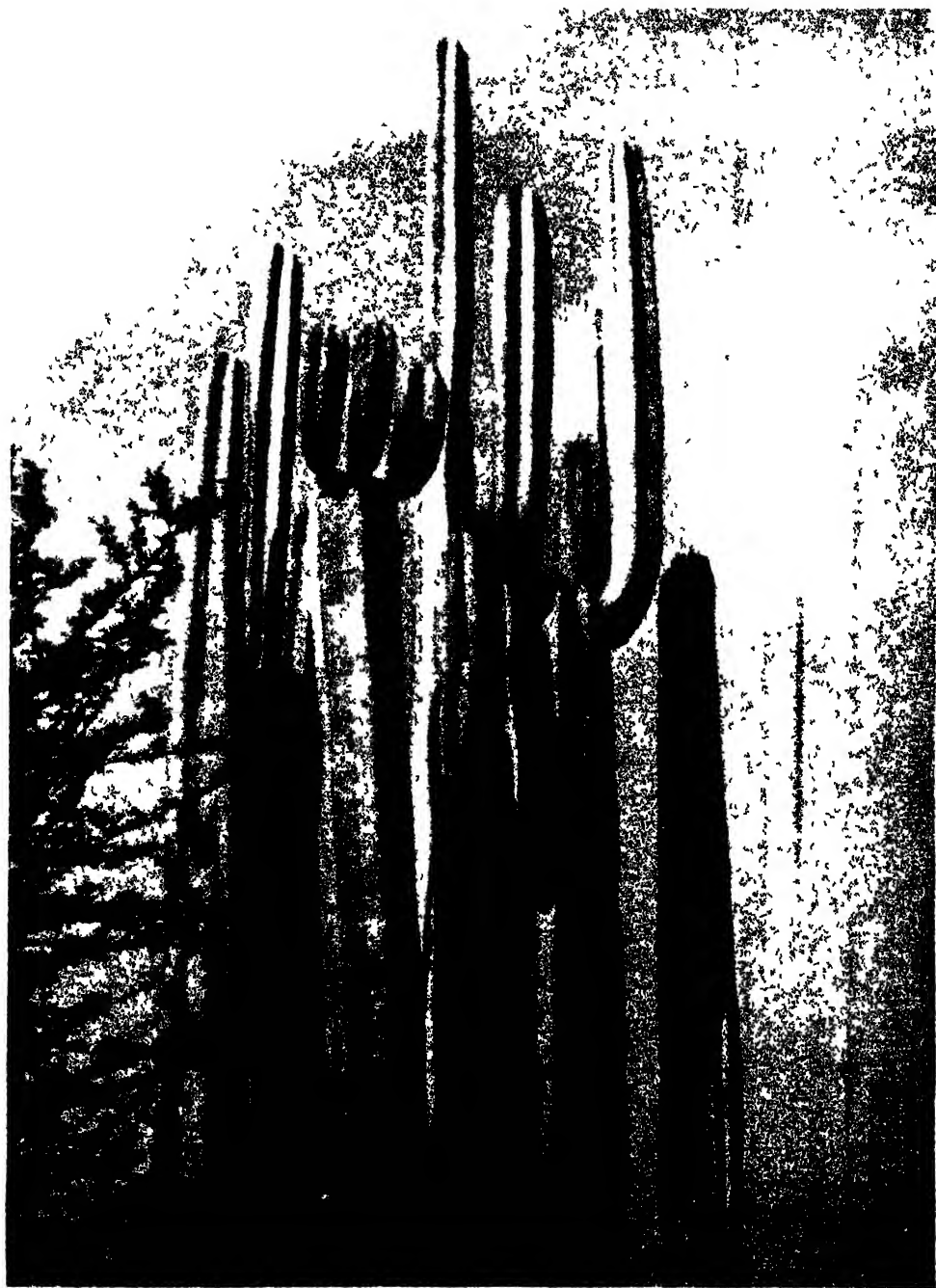
The Mistletoe Cactus is also a spineless member of the family; it is usually an epiphyte, its fibrous aerial roots hanging downward into the air as do the branching stems which are cylindrical, flattened or angular. In some cases the flattened stems look like long narrow leaves with lobed margins. The flowers are very small, usually white or yellow, and produce small globular fruits. It is the only genus in the family that has established itself outside of the Americas, eleven of the fifty species being



Old Man Cactus (*Cercus senilis*) grows a tawny wool among the long spines, forming a tangled mass which gives the species a venerable and hoary appearance. Huntington Botanical Garden, San Marino, California.

found in south Africa, Madagascar and Ceylon. One species has become naturalized in the Florida hammocks and Keys.

The Christmas Cactus of Mexico and Central America is a plant which is commonly potted and grown for its large showy flowers. The spineless stems are flattened and leaf-like, branching profusely. The commonest cultivated variety of Christmas Cactus bears at the tips of its stems large flowers of bright scarlet.



Pachycereus marginatus, the slender columns soaring skyward in modernistic lines, is a Mexican species. Huntington Botanical Gardens, San Marino, California

CHAPTER XXVI

The Geranium Family and Its Relatives



THERE are a number of families, each with a few common flowers or trees of which some are of economic importance, that are grouped together in the Geranium Order. This includes the Geranium Family and its botanical relatives the Wood Sorrels, Flax, Milkworts and Polygalas, and the Spurge Family.

THE GERANIUM FAMILY

A few common flowers are found in the Geranium Family (*Geraniaceae*). They vary in flower structure, some being regular and five-parted similar to the Roses, others being irregular with unequal sized petals. Of six hundred or more species, mostly small plants of temperate regions, only a few occur in the United States.

Cranesbill or Wild Geranium (*Geranium*) is a familiar flower of woods and fields ranging from New England to Georgia and west to Kansas. The flower has five light purple petals which are hairy at their base; the leaves are compound, divided into five segments which are again lobed into smaller sections. Herb Robert is a related species of the northeastern states with smaller lavender- or rose-colored flowers and usually three-parted leaves. Several European species have become naturalized and may be found wild in the eastern and southern states. West of the Rocky Mountains there is the Western Cranesbill with similarly lobed leaves and rose-purple flowers; it is found in the pine belt of the mountains from California to Canada. The name "cranesbill" well describes the long bristle-tipped fruit which projects from the flower stalk like a bird's bill.

The Storksbill (*Erodium*) of the eastern and central states is a naturalized European plant with pinnately compound leaves and pink flowers, and a low spreading habit. Our native species include the Desert Storksbill with silvery white sepals and purple petals, living in the California deserts; and the White Storksbill of the coastal ranges and valleys of the same state.

The familiar potted Geraniums (*Pelargonium*) are related plants from southern Africa; the scientific name comes from the classical word for "stork" applied to the long slender fruits. Geraniums have showy irregular flowers which are quite different from those of our native Geraniums. The two upper petals are usually larger and differently colored than the others, and the calyx is prolonged into a nectar spur that grows back along the flower stalk. The parent of the cultivated Geraniums was in-

roduced into England about 1690; the English and the Dutch were the first to popularize the flower. Geraniums have lobed, often deeply subdivided leaves—sometimes variegated with bands of green, red or white—and clustered flowers commonly some shade of red or pink.

THE WOOD SORREL FAMILY

There are likewise only a few native flowers in the Wood Sorrel Family (*Oxalidaceae*) which includes three hundred species of chiefly tropical plants. The flowers



GERANIACEAE

Wild Geranium, cultivated Geranium, Eastern Storkbill.

have a regular five-parted calyx and corolla, and the leaves are pinnately or palmately compound.

Wood Sorrel (*Oxalis*) is a creeping plant with clover-like compound leaves and delicate white flowers often striped with pink. The scientific name refers to the acid taste of the leaves, originating from the Greek word for "sharp". Wood Sorrel is decidedly a flower of cool, shaded and damp woods where it forms a thick ground cover in the deciduous forests on the slopes of the mountains. It ranges from New England southward in the mountains to Tennessee and west to the Mississippi River. Redwood Sorrel, a plant of the shady redwood forests of California and Oregon, has white or pink petals frequently veined with purple. Varieties of *Oxalis* from Mexico, tropical America and tropical Africa are often used as bedding plants in gardens.

Violet Wood Sorrel (*Ionoxalis*) grows from a bulbous base, producing purple

or violet flowers in low clusters. It is a plant of rocky woods and prairies ranging from the Atlantic coast to Texas and Colorado.

Sour Grass or Yellow Sorrel (*Xanthoxalis*), a larger plant with clusters of yellow flowers, is a European immigrant which has escaped and become a weed in many states. There are, in addition, several native species with yellow or purple flowers, found in the central and southern states.

THE FLAX FAMILY

The Flax Family (*Linaceae*) is one of the most important families in the Geranium Order; there are only a hundred and fifty herbaceous and shrubby members in the family, but one of them has been cultivated since prehistoric time as a fiber plant. Most of the species have simple narrow leaves and five-parted flowers.



OXALIDACEAE

Wood Sorrel and Sour Grass

Blue Flax (*Linum*) is a native species found in the central and western states, from Nebraska and Texas to the Pacific coast. It is an erect plant with linear upward pointing leaves and blue flowers at the tips of the stems. Yellow Flax (*Cathartolimum*) is a related plant with yellow or white flowers, common in roadside thickets and meadows in the southeastern and central states.

Commercial Flax (*Linum*) is a native of Asia, Europe and Africa—but it has been under cultivation for so many centuries that the “wild” form is now unknown. It often escapes from cultivation and has become naturalized in some parts of the United States. Flax is a branching plant with linear leaves and blue or white flowers, similar to the native Blue Flax but an annual instead of a perennial. Flax was known and used by the Egyptians and Greeks; ropes from ruins of the prehistoric Swiss lake dwellings show that the plant was used even then. Under the bark are the fibers—slender thick-walled cells each about an inch in length—which are united into long strands, serving the plant as a supporting skeleton. The flax plants are cut down and the stems left lying on the ground exposed to the weather for several weeks; this separates the fibrous strips from the bark and the wood. The process of decomposi-

tion (which does not affect the cellulose fibers) is further hastened by retting in tanks of water. The fibers, eventually separated from all the other plant parts, are then ready to be made into linen. Linen is stronger than cotton because the flax fiber cells are thicker-walled than those of cotton; for this reason it is used in making such articles as carpets, fish line and thread. Flax grows well in a cool climate where other fiber plants such as cotton could not grow; it is an important crop in Ireland and Russia, and in the United States in Montana, North Dakota and Minnesota. In addition to its value in yielding fibers for linen, the Flax plant has seeds rich in oil. The seeds are compressed into a cake and the oil squeezed out to become the linseed oil of commerce, an important part of the paint and varnish industry. Mixed with ground cork, linseed oil is pressed upon canvas to make linoleum.



L. NACFAR

Commercial Flax, Blue Flax and Yellow Flax.

THE MILKWORT FAMILY

The Milkwort Family (*Polygalaceae*) is a large one, but most of the thousand species are tropical in their distribution. Only a few occur in the United States and all of these species are of the same genus (*Polygala*). The flowers are irregular with five sepals and three petals; the two lateral petals are large and colored, and the lower is crested or keel-like.

Seneca Snakeroot or Mountain Flax is a species with greenish-white flowers in slender spikes or short clusters on stems which grow in groups from a thickened root. It grows in dry rocky woods from New England to North Carolina and west to the Dakotas.

Fringed *Polygala* has one to three large rose-lavender flowers, each with a fringed lower lip. It is a beautiful little plant with few leaves, growing in the rich moist woods of New England and New York south to Georgia and west to Minnesota.

There are several kinds of Milkworts. The Orange Milkwort or Wild Bachelor's

Button, a plant of pine barrens and swamps of the Atlantic coastal plain, has small yellow flowers clustered in dense clover-like heads. Marsh Milkwort is a square stemmed plant with narrow leaves and purplish-green or white flowers in blunt cylindrical heads, as the name implies, it grows in bogs and wet meadows from the Atlantic coast to Nebraska. The common Field Milkwort is a fairly tall plant with the narrow linear leaves typical of most of the *Polygala* species, the greenish-purple flowers are grouped in blunt terminal heads, somewhat like those of the Marsh Milkwort. It is a plant of meadows and sandy fields from Maine to North Carolina, west to Kansas. West of the Rocky Mountains the genus is represented by the California



POLYGALACEAE

Seneca Snaketoot, Field Milkwort and Fringed Polygala

Milkwort, a purple flowering plant growing on wooded slopes of all the Pacific coast states, and the spiny Desert Polygala, likewise with purple flowers, of the desert areas of the Southwest.

THE SPURGE FAMILY

The Spurge Family (*Euphorbiaceae*) includes about four thousand species of herbs, shrubs and trees which vary greatly in their leaf, stem and flower structure. A few have flowers complete with calyx and corolla, but the majority lack the corolla, or both the petals and sepals. Some of the latter "naked" flowers have colored leaves and appendages which look like petals of flowers. Many of the members of the family have ordinary leaves and stems, but others are leafless, succulent and spiny showing a remarkable likeness to the Cacti. Economically the family is important because it includes the Para Rubber Tree—source of most of the world's supply of rubber, in the family is also the Castor Oil Plant, the Tapioca Plant and the ornamental Poinsettia. Our native flowers of the family include the Crotons, Silver Bush, Three-seeded Mercury, Queen's Delight, Snow-on-the-Mountain and the various Spurges.

Hogwort or Woolly Croton (*Croton*) is a scaly or woolly plant with oval or oblong leaves and small purple-tinged flowers in clusters. The flower of this and the follow-



Euphorbia antiquorum is one of many Cactus-like succulents of the Spurge Family, native to arid habitats in Africa. The small flowers are clustered along the spiny ridges of the fleshy stems. Huntington Botanical Garden, San Marino, California.

ing Silver Bush differ from the rest of the family by having a complete calyx and corolla. It thrives in sandy barren soil from New Jersey to Florida and west to Texas and Kansas. The genus is best represented in the Southeast, where over a dozen species are found; a few more occur in the central states and one on the Pacific coast. Silver Bush (*Argythamnia*) grows in rocky canyons in the southwestern deserts; it is a densely branching plant with silvery-colored foliage and white-petaled flowers. Related species occur as far east in the prairie states as Kansas.

The common genera which lack petals but have a calyx are the Three-seeded



EUPHORBIACEAE

Woolly Croton, Three-seeded Mercury and Queen's Delight.

Mercury (*Acalypha*) and the Queen's Delight (*Stillingia*). The former is a somewhat hairy plant with large leaf-like stipules at the base of the leaves; the small greenish flowers are clustered in spikes. The common eastern species ranges from New England to Florida and west to Nebraska. The latter grows in sandy soil from Virginia to Florida and westward to Kansas; the flowers, with a three-lobed calyx, are in the axils of bracts in a loose spike. Related species occur in the California deserts.

Snow-on-the-Mountain (*Lepadema*) gets its name from the resemblance of the showy flowers in the massed foliage, to a series of hilltops covered with snow. It is a stout plant with naked flowers—there being no petals or sepals. But the leaves immediately beneath the flowers are conspicuously white margined and petal-like in appearance; and glands on the leafy parts beneath the flower sometimes have pink or white appendages which also look like petals. Snow-on-the-Mountain is a prairie plant, common from Minnesota and Texas west to Montana and Colorado.

The Spotted Spurge or Milk Purslane (*Chamaesyce*) is one species of a large group with naked flowers seated in the midst of colored petal-like structures, usually white or red. It is one of thirty species, most abundant in the southeastern and central states.

Within recent years the Mexican Flame Leaf or Poinsettia (*Poinsettia*) has become a favorite Christmas plant; it is named after an American diplomat and Minister

to Mexico, Joel R. Poinsett. The flowers, themselves small and inconspicuous, have leaves immediately below them which are usually colored a brilliant red. The peculiar flower, typical of so many members of the family, is made up of a central entirely naked pistillate flower surrounded by similarly naked staminate flowers; these are all situated on a cup-shaped receptacle with petal-like outgrowths. The ornamental species is native to Mexico. The Painted Leaf is a native species, growing on wooded banks from Florida to Texas and Kansas.

Cassava (*Jatropha*) or Tapioca Plant is a shrubby tree of Brazil, characterized by



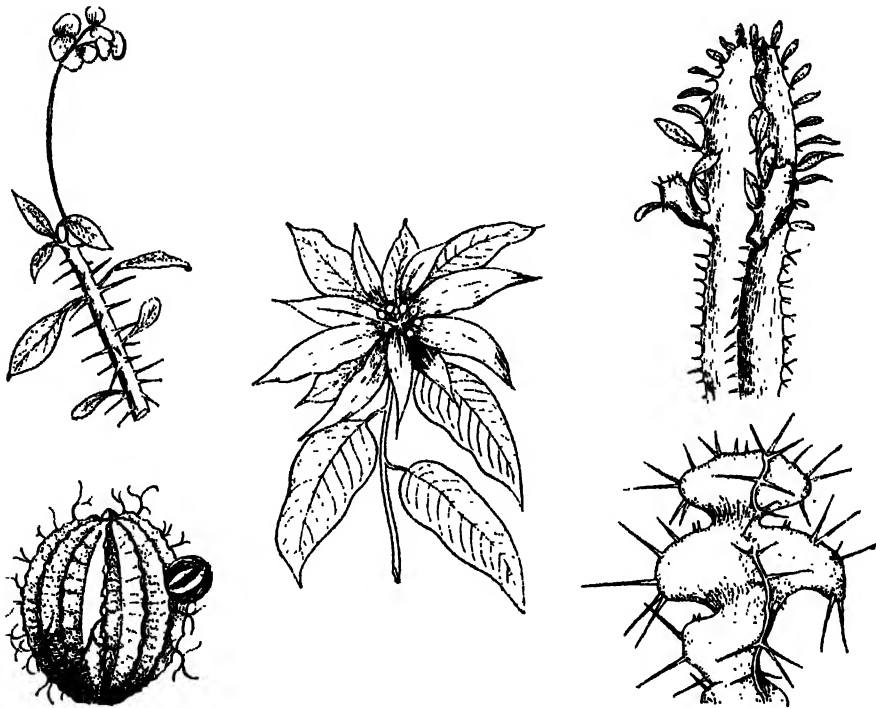
EUPHORBIACEAE

Castor Oil Plant, Para Rubber tree, Tapioca Plant.

fleshy roots which are rich in starches. This starchy material is used in making commercial tapioca. The presence of hydrocyanic acid in the roots makes them poisonous if eaten raw. The Tapioca Plant has become naturalized on the Florida Keys. Another species, the Ceara Rubber Tree, also of Brazil, produces a milky latex which is used in making certain grades of rubber.

The Castor Oil Plant (*Ricinus*) is a coarse plant with large lobed leaves, growing to be a thirty foot tree in the warmer countries, remaining an annual in our northern states. It is native to Africa, but has long been cultivated in various countries for the oily seeds which are the source of the medicinal castor oil. India is the chief producing region today, with Oklahoma the only state in this country which grows the plant on a commercial scale.

The Euphorbias (*Euphorbia*) proper are succulent cactus-like plants with spiny jointed stems and often with small leaves, reduced to scales; they are plants of dry desert regions in Africa, where they occupy a position similar to that of the Cacti in America. A common species of greenhouses is the Crown of Thorns, with a spiny practically leafless stem and bright red petal-like leaves beneath the flowers. The Euphorbias exemplify the biological phenomenon known as convergent evolution; that is, that two unrelated groups of organisms may gradually come to look alike if



EUPHORBIACEAE (*Euphorbia*)

Crown of Thorns (upper left), *E. meloformis* (lower left), Poinsettia (center), *E. hermentiana* (upper right), *E. grandicornis* (lower right).

they are exposed to the same environmental factors. Many of the Euphorbias are fluted, columnar, leafless growths closely imitating the Torch Cacti; others are spherical, compressed and ridged with thorns, as in the case of the Melon Euphorbia, and are the counterparts of the *Mamillaria* Cacti. There are many species which, when planted with the Cacti, are classed with them by the layman.

Rubber is a plant product derived from many different plants. We have already mentioned the India Rubber Tree, of the Mulberry Family, in Chapter 13. One of the Spurge Family, the Ceara Rubber Tree, has also been noted. But by far the most common source of rubber today is from the Para Rubber Tree (*Hevea*) which is native to the Amazon jungles. It is a large tree with three-parted compound leaves and inconspicuous green flowers. Just beneath the bark is a network of vessels which produce a milky substance known as latex; it is a mixture of water with globules of rubber. Just

what value these latex vessels are to the Rubber Tree no one knows. Incisions into the bark, which do not quite reach the wood, open up these minute vessels and the latex oozes forth ; exposure to air or heat causes the globules to unite in a doughy mass. When Columbus made his second visit to the new world, he found the native Indians using balls of this crude rubber to play with. But it was noted only as a curiosity for the next three centuries. Then it was introduced into Europe, and named "rubber" because its chief use was in erasing pencil marks ! Late in the last century, when the manufacture of rubber goods and accessories for the automobile industry created a demand for rubber, the wild *Hevea* Trees were tapped and the crude rubber collected and cured by the natives. During the process the trees were generally killed. To create a steady supply of the raw rubber, various countries began planting rubber groves in plantations ; the first to do so were the English who established plantations in Ceylon. Now there are many other plantations in the Malayan region, the Dutch East Indies, and in Africa. More than 90% of the world's supply comes from planted rubber trees. In recent years numerous experiments have been made with other rubber producing plants, especially those which would grow under American conditions. A promising plant is Guayule (*Parthenium*), of the Thistle Family, with some dozen American species.

The Rue Family



OUR native and introduced members of the Rue Family (Rutaceae) are predominantly woody plants with glandular dotted foliage. The group contains familiar flowers and fruits. The leaves are usually compound, often evergreen and with spines in the leaf axils. Foliage, fruits and flowers are noticeably aromatic and fragrant. Of the nine hundred or more species, the majority are tropical and sub-tropical plants. The introduced garden flowers of the family include Rue and Fraxinella; native shrubs and trees are represented by the Wild Lime, Satin Wood, Hercules' Club, Prickly Ash, Hop Tree, Torchwood and Turpentine Broom; introduced trees include the citrus fruits—Orange, Lemon, Grapefruit, Lime, Citron and Kumquat.

Rue or Herb of Grace (*Ruta*) is an old-fashioned garden favorite, its glandular foliage very aromatic. The leaves are divided into three finely lobed leaflets and the flowers, borne in terminal clusters, consist of yellowish-green sepals and petals—usually four or five of each. Rue was introduced into American gardens from the Mediterranean region, its native home; it frequently escapes and can be found naturalized in many of our eastern states.

Fraxinella or Gas Plant (*Dictamnus*) is also an old favorite among garden perennials, because of its strong lemon fragrance; it comes from southern Europe and northern China. The name Fraxinella refers to the Ash-like compound leaves. *Fraxinus* being the scientific name of the Ash; Gas Plant is a term applied to it because when a match is lighted beneath a flower cluster, the volatile gas ignites with a small flash. Fraxinella has showy white or rose flowers in large clusters; of the five petals one is unequally developed and inclines downward.

NATIVE TREES AND SHRUBS

Wild Lime (*Zanthoxylum*) is a shrub which sometimes grows to be a small tree, with pinnately compound leaves, small spines in their axils, and inconspicuous green or white flowers in tall, narrow clusters. The fruits are small and brown. Native to the West Indies, Wild Lime has become naturalized on the Florida Keys. A related species, known as Yellow Wood or Satin Wood, has orange-colored heart wood; it grows to be a spineless shrubby tree, also restricted to the Florida peninsula. Hercules' Club or Toothache Tree, also known as Southern Prickly Ash, is another species of the same genus; it is a spiny-stemmed shrub or tree reaching a height of

fifty feet—the largest tree in the family. Hercules' Club grows in woods and thickets along the coastal plain from Virginia to Texas. The deciduous leaves are pinnately compound, with three to nine pairs of leaflets; the flowers are inconspicuous and grouped in loose clusters. The bark is collected by Negroes in the south and used as a cure for toothache and rheumatism. The remaining species of the genus is the Northern Prickly Ash, an aromatic shrub with prickly stems, found in rocky woods and along river banks from New England to Georgia and west to Kansas. The small



RUTACEAE

Wild Lime and Eastern Hop Tree.

yellowish-green flowers, appearing in spring before the leaves, consist of only four or five petals; there are no sepals. Each of the compound leaves is made up of two to four pairs of leaflets.

The Hop Tree (*Ptelea*) is a shrubby tree rarely more than twenty feet tall, with spineless branches and compound leaves each consisting of three leaflets. The flowers are greenish-white and borne in open clusters, each flower of four or five sepals and a like number of petals. The small dry fruit is entirely surrounded by a flat circular wing. Hop Trees grow in rich woods over a wide range, being found from New England to Florida, west to Arizona and Minnesota. Three other species grow in Florida and near-by states. The bitter strongly scented bark is supposed to be valuable as a tonic. On the Pacific coast is the Western Hop Tree, growing on the coast ranges and in the Sierras of California; it has the same compound leaf with three leaflets and a similar winged fruit.

Torchwood (*Amyris*) is a shrubby tree found only in southern Florida. Each compound leaf consists of three leaflets, and small white flowers are borne in open clusters, producing a fleshy black fruit rich in an aromatic oil. The wood is heavy and close-grained, sometimes used in cabinet work.

Turpentine Broom (*Thamnosma*) is a strongly scented switch-like desert shrub with yellowish-green, glandular stems and narrow short-lived leaves. The flowers,

each with four petals and four sepals, are small and dark purple. Turpentine Broom is one of the few members of the family which has invaded the dry stony hills of the deserts in our southwestern states.

THE CITRUS FRUITS

The citrus fruits are almost all different species and varieties of the one genus *Citrus*, which has no representative native to the United States, though a few species have escaped and established themselves in the congenial climate of Florida. The *Citrus* genus is characterized by an edible fruit which consists of an oily rind or skin surrounding a fleshy pulp which is divided into compartments. In this genus we find the Orange, Lemon, Grapefruit, Citron and Lime.



RUTACEAE

Sweet Orange, Grapefruit and Lemon.

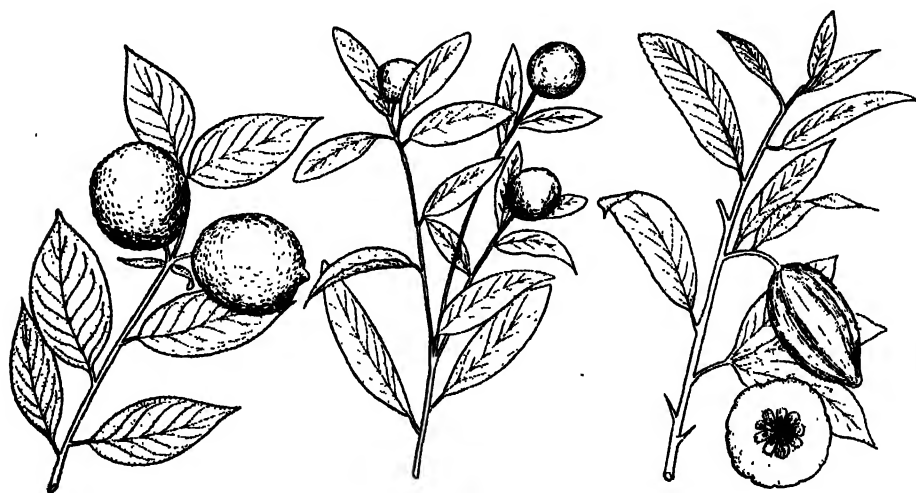
Oranges are native to the hilly region of Indo-China, where there are two common species—the Sour or Seville Orange and the common Sweet Orange. The Sour Orange is a small tree with elliptical leathery leaves really divided into three leaflets; though the terminal leaflet is the most conspicuous and the two lateral leaflets are reduced to small flat wings on either side of the stem. There are spines in the axils of the leaves. Each blossom has a three- to six-lobed small calyx and four to eight thick waxy-white petals. All orange blossoms have an exquisitely aromatic fragrance. The fruit of the Sour Orange is dark orange in color, with a thick skin and a sour pulp. This was the first orange to be introduced to the western world. Although cultivated as long ago as 3000 B.C. in China and India, it was not introduced into Europe until the twelfth century of the Christian Era. It was introduced into Arabia and Persia by the Arabs, and from there was brought to Europe via Syria, northern Africa and Spain in the wake of the Mohammedan invasion. It was at least three hundred years later before the Sweet Orange, brought direct from China by Portuguese sailors, became a cultivated European fruit. The Sour Orange was perhaps the first fruit tree imported into this country, being brought to Florida by the Spaniards, and spread in that state by the Indians so that today groves of wild Sour Oranges are found around



Fraxinella (*Dictamnus albus*) is an old favorite among garden perennials, because of its strong lemon-like fragrance. New York Botanical Garden.

the lakes and rivers. Sour Oranges are grown in the United States chiefly as a stock on which to graft the less hardy Sweet Orange. Under the name of Seville Orange, it is grown in Spain and the fruit shipped to England and Scotland to be made into marmalade. The peel is also candied, and the flowers yield a perfume known as oil of Neroli.

The Sweet Orange, a more delicate tree, forms a dense round head of foliage which is glossy dark green in color; the leaves have a much narrower wing and the spines, when present, are more flexible than those of the Sour Orange. Sweet Oranges were introduced into Florida some time before the English occupation; groves were found in various places as early as 1800. A Sweet Orange grove, found in 1823, is



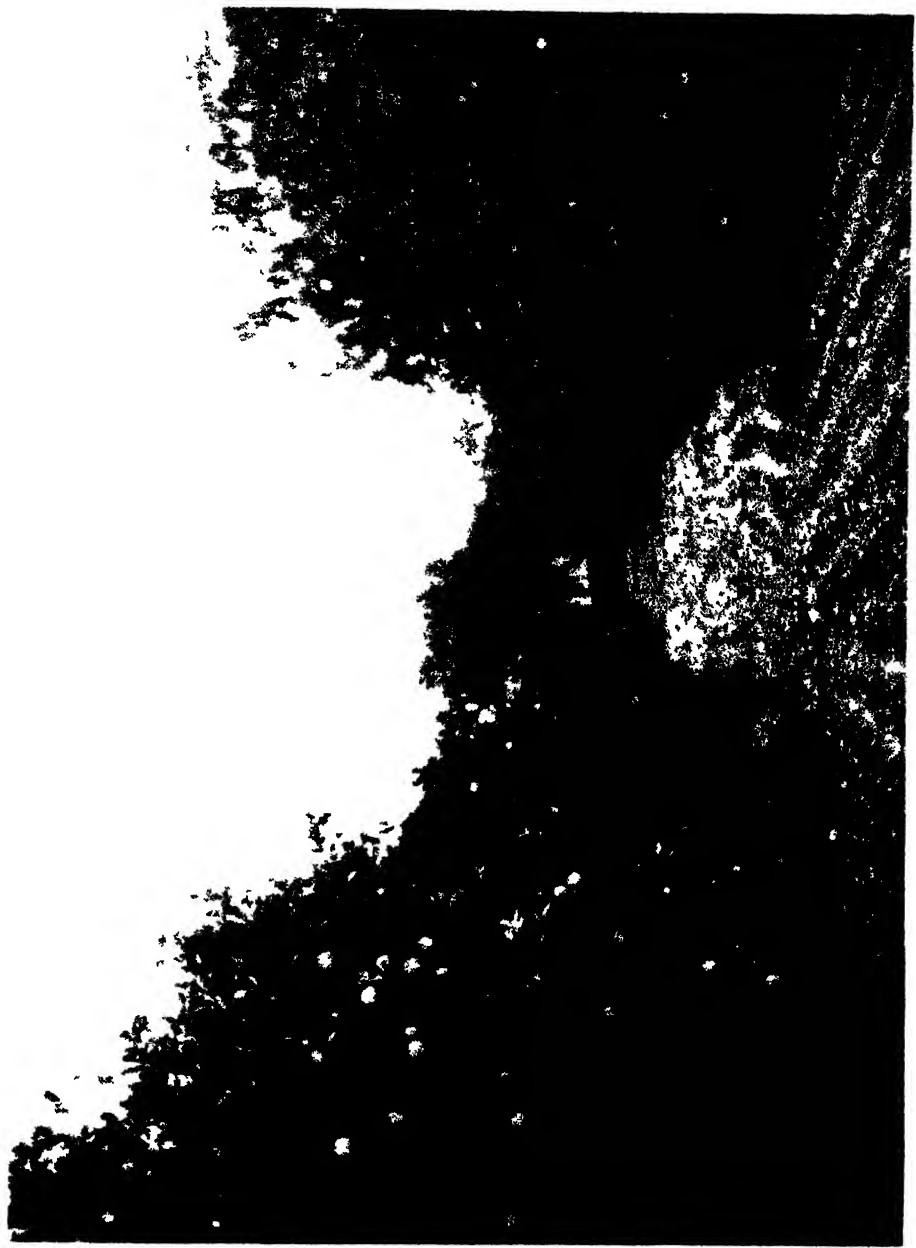
RUTACEAE

Lime, Kumquat and Citron.

said to be the parent stock of the famous Indian River varieties. Orange growing in Florida began around the shores of the lakes and rivers where the wild Sour Orange groves were already established and upon which the Sweet Oranges were grafted. Oranges were grown even in the northern part of the state until 1895, when a killing frost crippled the whole Florida orange tree population; since then, practically all the oranges have been grown in the southern frost free part of the state. Today Florida ranks second only to California in the production of this citrus fruit. The Florida orange crop is picked for market from October to June.

In the gulf states, especially in the delta region of Louisiana, citrus fruits have been grown with some success. The Creole or Louisiana Sweet Orange is gradually becoming an important competing crop, since it matures earlier and can reach the markets before the Florida or California crop. This frost resistant strain was developed by grafting a Japanese variety on to the hardy Trifoliate Orange.

Orange growing began much later in California than in Florida; but after transportation facilities to the eastern markets were improved, this crop soon became an important asset to the state. Spanish Jesuits planted the first orange trees at San



Grove of Sweet Oranges (*Citrus sinensis*) ready for picking, Claremont, California

Gabriel Mission in 1804 ; about forty years later the first commercial grove was planted in what now is the city of Los Angeles. In 1877 the first carload of California oranges was sent across the Rocky Mountains to the east. Soon there were hundreds of thousands of acres devoted to growing this one fruit, until today the orange industry of California represents an investment well over a quarter of a billion dollars. The best orange growing regions are in the valleys inland from Los Angeles where the temperature and soil conditions are best suited for orange culture. Because of the effectiveness of the mountains as barriers against cold northerly winds, oranges can be grown in California in the same latitude as New York City or Nebraska. Frosts are, however, common and dreaded by the growers. To protect the fruit, hundreds of smudge pots which burn crude oil are always on hand in the groves ; when a frost is predicted, these burning smudge pots fill the air with a dense sooty smoke which acts effectively as a blanket over the trees, but unfortunately deposits a sooty film also over everything else in the vicinity. To remedy this, gas-burning orchard heaters are gradually replacing the old smudge pots.

Of the many varieties produced in this country and abroad, the Valencia—originating in the Azores and introduced to the United States in 1870—is the most popular, especially in California. The Valencia crop is harvested from June to November. The Navel is a peculiar orange with a smaller secondary fruit formed at the tip of the main fruit ; the common variety, introduced from Brazil, is a seedless tough-skinned but desirable juicy orange which is the most commonly grown orange in California. Two trees were sent to Riverside, California, in 1873 by the Department of Agriculture ; one of these citrus patriarchs is still standing in that city, well guarded by an iron fence. These are considered the parent trees of the nine million descendants and relatives now growing in California, which, in 1937, produced fourteen million boxes of fruit. In 1880 another species—the King Orange—was brought to Riverside, California, from Cochin China ; this fruit has a thick, rough and unattractive skin which is loose and easily removed from the juicy pulp with its peculiar vinous flavor. From it such common varieties as the Mandarin and Satsuma have been derived, grown extensively in Florida. The Tangerine is another variety of the King Orange—characterized by an easily removed rind and pulp divided into compartments readily separated. The Citrange is a cross between the Trifoliate Orange and the Sour Orange, grown in the cotton belt because of its hardiness, even though the fruits are small and not as sweet as regular oranges. Another hybrid, known as the Tangelo, is the result of crossing a Grapefruit and a Tangerine.

Grapefruit or Pomelo is a large tree with leaves that are definitely winged like those of the Sour Orange. From its home in Polynesia and the Malay Archipelago its cultivation has spread to the West Indies and from there was introduced into Florida by the Spaniards. Until thirty years ago it was grown but sparingly and was little known. Since then it has increased in popularity and has become cultivated in greater acreage. Grapefruit get their name because the fruits grow in clusters like huge bunches of grapes ; the large globose fruits—often six to eight inches in diameter—are the largest of the Rue Family. The trees are more susceptible to cold than most citrus fruits, and thus can be grown profitably only in regions without frost. The most important grapefruit producing states are Florida, California, Arizona and Texas.



Grapefruit (*Citrus grandis*) clusters on the trees. Sebring, Florida.

Lemons grow on small trees, rarely more than twenty feet tall, with thorny branches and flowers with a purplish tinge to the outside of the otherwise white blossoms. The Lemon is native to India, and was brought to Spain by the Arabs in about the twelfth century; together with the Citron, the Lemon was one of the first citrus fruits to be known in the Mediterranean region, being grown in vases by the Greeks and Romans. Lemon trees are very sensitive to frost, and can be grown commercially only in the hottest parts of California and Florida; but even there smudging is often necessary in order to save the crop. The islands and coasts of the Mediterranean are a most favorable region for lemon culture; it is there that the European crop is centered. Lemons were an important crop in Florida until an unusual cold spell in 1895 and a wide spread fungous disease killed thousands of trees. California is now the leading lemon producing state, most of the groves being located near the seacoast from Los Angeles to San Diego, where there are warm winters and a suitably cool and moist summer climate. Lemons, being produced on the trees the year round, are picked continuously, some ten or twelve times a year. Since the best picking is from December to March, the crop is held in storage to be released in summer when there is a greater demand and better prices. Lemons are used for lemonade and extract—ranking second in importance only to vanilla for this latter purpose.

The Citron is a native of India, closely related to the Lemon and with the same purple-tinged blossoms; the leaves are larger, as is the rough and thick-skinned fruit with its relatively small amount of pulp. The tree itself is shrubby and armed with stout thorns. Citron is cultivated most extensively in the Mediterranean region, and only slightly in California and Florida. The chief use of this citrus fruit is in the form of candied peel used in cooking.

The Lime fruits used as a source of fresh fruit drinks come from a species of *Citrus* widely spread through the tropics, in Ceylon, India, West Indies and Mexico. It is a small tree with short stiff spines, small leaves and small white flowers. The fruit is greenish-yellow, both in color of pulp and the external rind; the latter is so thin that the Limes can not be packed and stored as are the Lemons. Limes are grown to a limited extent on the Florida Keys, but our supply comes chiefly from the West Indies or Mexico.

A little grown citrus fruit known as the Kumquat (*Fortunella*) was introduced into England from China in the middle of the last century by Robert Fortune, a collector for the Royal Horticultural Society of London. It is a dwarf evergreen tree with elliptical leaves and small orange-like fruits the shape and size of very small plums. Kumquats are eaten whole, since the skin and entire contents are edible. They are a hardy fruit compared with other members of the family, thriving as far north as Georgia.

The Maples and Their Relatives



IN THIS chapter we shall become acquainted with a number of families of woody plants which usually grow to be shrubs or trees; they are all grouped into the Soapberry Order (*Sapindales*), and include a few wild flowers such as Bittersweet and Jewelweed (see Chapter 46). The families of the order which we will consider are the Maples, Horse Chestnuts, Hollies and Sumacs.

THE MAPLE FAMILY

The Maple Family (*Aceraceae*) is made up of only two genera and less than a hundred species; one genus (*Dipteronia*) is represented by a single tree which is native to China, the other (*Acer*) includes the familiar Maple trees of our woods as well as the ornamental varieties used as street and shade trees. Maples are trees with opposite leaves which are simple and palmately lobed in all but one of our native species; in autumn the foliage turns brilliant red and yellow, according to the species. The small flowers grow in compact clusters, appearing with or before the opening of the leaf buds; the calyx is usually five-parted, as is the corolla when it is present, and the stamens and pistils are often conspicuous projecting structures. In some of the early flowering Maples such as the Red and the Silver Maple, the flowers are attractive even though small. The fruits are flattened nutlets formed in pairs and each provided with a long papery wing for wind dispersal; some of the Maples have bright red fruits. A few of the species are valuable as timber trees, and maple sugar and maple syrup are secured from the Sugar Maple.

The Maple with compound leaves is the Box Elder or Ash-leaved Maple, whose leaves are divided into three to five leaflets. This is a medium-sized tree, growing to be seventy feet in height, with gray or brown ridged bark and yellowish-green flowers which lack petals. Box Elder grows best in rich moist soil such as is found along lake margins and river banks from New England to Florida, westward to Oklahoma and Kansas. Varieties occur in New Mexico, Arizona and California. It is used principally for shelter belt planting in the west, since it can withstand considerable drought and cold; the wood is of little value. Several Chinese and Japanese species with similar compound leaves are sometimes cultivated as ornamental trees.

All the remaining Maples have simple leaves, usually palmately lobed. These include three western species, two small trees of the eastern states, and the larger Sugar

Maples, Chalk Maple, Silver Maple and Red Maple of the central and eastern region

The Dwarf or Sierra Maple, a shrubby tree rarely more than twenty feet high, is widely distributed from the Rocky Mountains to the Pacific coast, growing on mountain slopes at altitudes varying from five to six thousand feet. The broad leaves have three to five lobes sometimes so deeply divided that they look like three-parted compound leaves. The small flowers are borne in drooping clusters. Very similar in habit is the Vine Maple, also a shrubby tree of the Pacific Coast states, thriving along the banks of streams. The Vine Maple has almost circular leaves which are seven to nine



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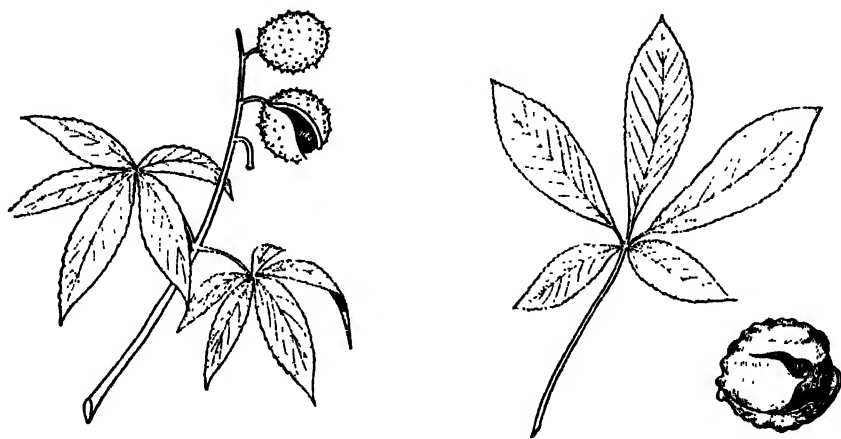
Box Elder (*upper left*), Sugar Maple (*lower left*), Oregon Maple (*center*), Red Maple (*upper right*) and Striped Maple (*lower right*)

lobed, and scarlet fruits usually standing in erect clusters. The other common western Maple is the Broad-leaved or Oregon Maple found in rich bottom lands and mountain valleys from Washington to California. This has a stout straight trunk, a compact head of foliage, and grows to a height of a hundred feet. The unusually large leaves are often ten inches in breadth, and deeply divided into five acute lobes.

In the central and eastern states grow two small species, the Mountain Maple and the Striped Maple, both with flowers having petals as well as sepals. The Mountain Maple is a shrubby tree rarely more than thirty feet tall, usually growing under the shade of other trees. It is common in moist woods from New England southward in the mountains to Georgia and west to Minnesota and Iowa. The yellowish-green

leaves are slightly three- to five-lobed, and the flowers are borne in erect cylindrical clusters. Striped Maple or Moosewood grows to about the same height, likewise in the shade of other trees, and in practically the same area. The greenish-colored bark of young trees is marked with lengthwise lighter stripes; the three-lobed leaves are the largest of the eastern Maples, often reaching six inches in width.

The flowers of the remaining Maples lack petals, and the sepals are more or less united; here we find most of our common eastern members of the family. The Rock or Sugar Maple is a large tree, reaching a height of 120 feet and branching profusely to form a dense round-topped dome of foliage; it ranges from the cool deciduous forests of New England west to Iowa and the Dakotas, south to Arkansas. The leaves are broad and a glossy green, divided into three to five lobes with toothed margins.



HIPPOCASTANACEAE

Ohio Buckeye and California Buckeye.

The greenish-yellow flowers appear with the leaves. In autumn the foliage turns a warm yellow, transforming country roads into aisles beneath vaulted roofs of translucent gold. Economically it is the most important Maple, the tough, close-grained and hard wood being widely used for interior finish, floors and furniture. Occasionally there are forms with curled and twisted annual rings, resulting in the peculiar grain of "curly maple" and "bird's-eye maple." In northern New England the trunks are tapped for the sugary sap which flows in the early days of spring; this is boiled in large kettles and made into maple syrup and maple sugar. The Southern Sugar Maple is a medium-sized tree of wet woods from Virginia to Texas, its rounded leaves having three to five obtuse lobes; this is a common tree along the streets of some of the southeastern cities. The Western Sugar Maple grows in mountainous river valleys in Wyoming, Montana, Idaho and adjacent states, growing at altitudes of five to six thousand feet. Its leaves are shallowly three-lobed. A common maple of Iowa, South Dakota and the nearby prairie states is the Black Sugar Maple, a medium-sized tree with three-lobed leaves which are usually rimmed with tooth-like projections.

The Silver or Soft Maple is a tall tree with pendulous branches and scaly or furrowed gray bark. The leaves are quite different from those of the other maples, being

more deeply cut into five toothed lobes, separated by narrow sinuses; and with the undersurface a silvery gray-green. The red flowers appear before the leaves. The wood of the Silver Maple, though hard and strong, is too brittle for general use; it is sometimes used for interior finish and cheap furniture. The Silver Maple is native to shady stream margins in the woods of New England, southward to Florida and west to Nebraska.

The Chalk Maple is a small tree inhabiting our southeastern states, conspicuous for its light gray bark and broad three- to five-lobed leaves; the yellow flowers in spring and the bright scarlet leaves in autumn make it a colorful member of the maple genus.

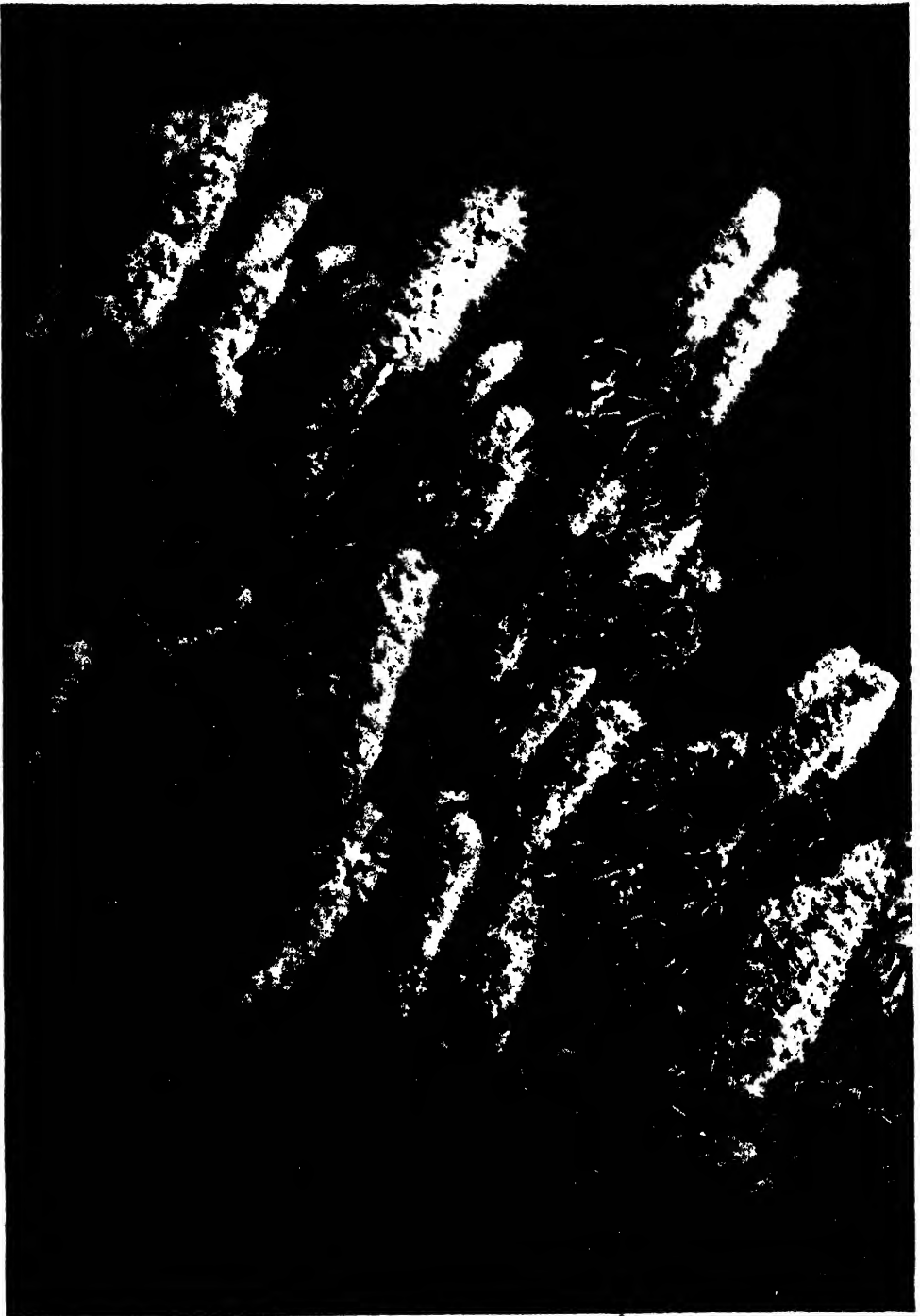


AQUIFOLIACEAE

American Holly and Dahoon.

The Red or Swamp Maple is a common tree of swamps and wet woods in the northeastern states and along the Atlantic seaboard, where it is responsible for masses of brilliant red color in spring, because of its red flowers and fruits, and in autumn, because of its scarlet leaves. Red Maples have gray bark, especially smooth and lighter in color on the younger branches; the three- to five-lobed leaves are glossy green on their upper surface, dull gray-green on the under side. This species is found as far south and west as Texas. A southern swamp in spring, with the scarlet of the Red Maple flowers or fruits, set off against the silvery gray haze of Cypress trunks, with occasional dashes of sunny yellow where the Jasmine climbs over the still leafless branches, is a masterpiece in color.

The Norway Maple, native to Europe, is one of the most familiar of the introduced trees of the family, especially in the eastern states where it is frequently used as a street and lawn tree. This is a large tree with fairly smooth gray-brown bark, five-lobed leaves with pointed teeth along their margin, and yellowish-green flowers. Numerous Japanese and Chinese varieties of other Maples are often grown for their ornamental vari-colored or tinted foliage.



The California Buckeye (*Aesculus californica*) is a showy-flowered shrub abundant on the hillsides of the lower mountains; the erect clusters of this Buckeye tree are greeting the morning sun as it rises over the mountains of Sequoia National Park, California.

THE HORSE CHESTNUT FAMILY

The Horse Chestnut or Buckeye Family (*Hippocastanaceae*) is a small family with about twenty species belonging to only two genera; the Mexican and Central American genus *Billia* and the Horse Chestnut or Buckeye (*Aesculus*) of North America, eastern Asia and the Balkans. This genus is characterized by large compound leaves with leaflets arranged like the fingers of a hand, and by conspicuous erect flower clusters varying in color from white to red or yellow. Each flower has a four- to five-



ANACARDIACEAE

Staghorn Sumac (*upper left*), Laurel Sumac, Dwarf Sumac (*upper right*), Lemonade Berry.

toothed calyx and a corolla of four or five petals which have long narrow stalk-like bases. The fruit is the familiar "chestnut", a dark brown capsule resembling a nut, and protected by an outer husk which may be smooth or prickly. Our native species are chiefly central and western in their distribution.

The Ohio Buckeye is a small tree of rich river bottoms and stream margins, ranging from Iowa and Kansas to Texas and Alabama. Each leaf is made up of five leaflets and the yellow blossoms produce a prickly fruit. The light, soft wood is used in making artificial limbs and various articles of woodenware. A more eastern species is the Yellow or Sweet Buckeye, a slightly larger tree with five to seven leaflets to each compound leaf; yellow, red, or pink flowers; and a fruit without prickles. This



The elegant erect clusters of the European Horse Chestnut (*Aesculus Hippocastanum*) are larger than those of the native species. Hamilton, New York.

tree frequents river bottoms and mountain slopes of Pennsylvania south to Tennessee and Georgia, west to Indiana and Ohio. The wood is used for the same purposes as the Ohio Buckeye. The Red-flowered Buckeye is a shrubby tree of woods throughout our southeastern states; its compound leaves consist of five narrow pointed leaflets. The red blossoms form long clusters of from six to eight inches in length.

The sole western representative of the genus is the California Buckeye, growing on the dry hills and canyon slopes of the California mountains, at altitudes below four thousand feet. This small tree, rarely twenty feet high, has four to seven elliptical leaflets in each compound leaf, and white or pink flowers in large cylindrical clusters.

The European Horse Chestnut, a native of Greece and Bulgaria, is a commonly



ANACARDIACEAE

Poison Sumac and Smoke Tree.

cultivated ornamental tree which is strikingly beautiful when in blossom. The compound leaves are each made up of five to seven elliptical leaflets, the central ones larger than the others. The erect clusters of snowy white flowers, sometimes tinged with pink, rise like many stout candles from the midst of the dense mass of foliage.

THE HOLLY FAMILY

Although the Holly Family (*Aquifoliaceae*) includes some three hundred species, most of them are Central and South American in their distribution; all but one of the few representatives in our flora belong to the genus *Ilex*, or True Holly. These are trees or shrubs with evergreen or deciduous simple leaves which are often thick and spiny toothed; the flowers are small and greenish white, with a four- to six-lobed calyx and a similar number of petals, the latter being short-lived and soon falling off the flower. The red or black berry is in reality a small stone fruit.

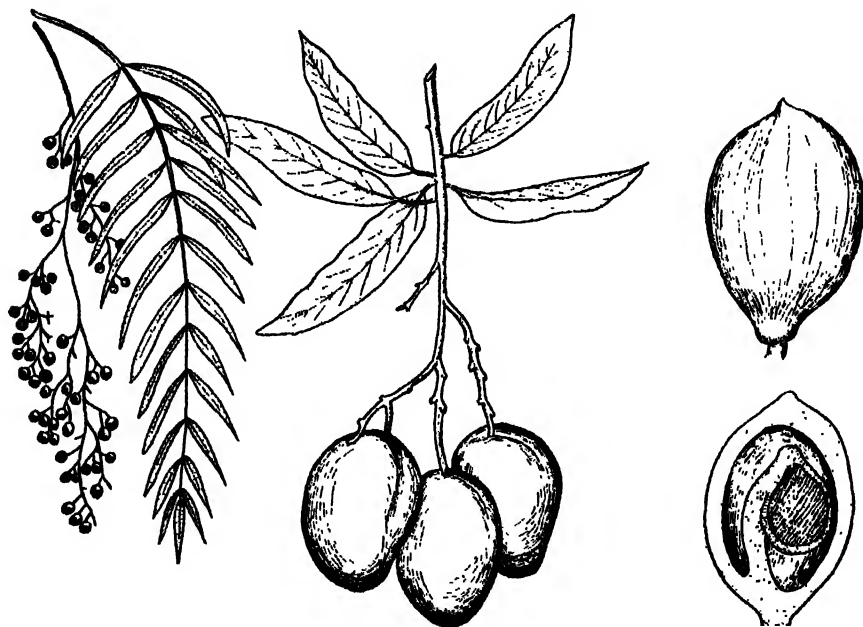
The most common member of the genus is the American Holly, ranging from New England to Florida and west to Texas—a shrub in the northern portion of this region,



Staghorn Sumac produces pyramidal clusters of reddish-brown fruits in autumn. Penobscot Bay, Maine.

but a tree frequently fifty feet high in southern Arkansas and adjacent states. The leaves are small and elliptical, armed with a few stout teeth along the margin and a dull yellow-green in color; they persist on the branches for several years. The fruit is the familiar red Holly berry.

Most of the other Holly species are plants of the southeastern states. Dahoon is a shrubby tree found in cold swamps and wet woods from Virginia to Louisiana, with smooth margined leaves and red or yellow berries. Yaupon, another shrubby form, is common near the seacoast; it has minutely toothed leaves and scarlet berries. The leaves of Yaupon have emetic and purgative properties, and were used as a medicinal



ANACARDIACEAE

Pepper Tree, Mango, Pistachio (external and section view of fruit).

drink by the southern Indians. The Black Alder or Winterberry is a shrub of swampy woods from Florida to Missouri and Minnesota; and a closely related Smooth Winterberry is found in the swamps from Georgia to Pennsylvania. The Deciduous Holly is a shrubby tree with a greater range, being found from Maryland to Florida and west to the prairie states. Evergreen Hollies of the southeastern states include the Ink-berry, a low shrub with velvety twigs, entire leaves and black fruits; and the Large Gallberry, a taller shrub with spiny-tipped leaves and larger black fruits. Mountain Holly is a shrub with toothed leaves and bright scarlet berries, common to the mountainous region from New York to Alabama and Georgia. Another plant, also known as Mountain Holly (*Nemopanthes*)—differing chiefly in its floral anatomy—has deciduous entire leaves and red fruits; it grows in damp cool woods from New England to Virginia and west to Indiana.



Poison Ivy (*Toxicodendron radicans*) is an all-too-common vine of our eastern states; it can be recognized by the compound leaves each with three leaflets. Hamilton, New York. Photograph by O. B. Stanley.

THE SUMAC FAMILY

The numerous members of the Sumac Family (*Anacardiaceae*)—there are about five hundred species—are trees, shrubs or vines with a milky, resinous, often acrid, sap which is a powerful skin poison in some species. In addition to the various kinds of Sumacs, the family is represented in the United States by Poison Ivy, Poison Oak, Poisonwood, Pistachio and Smoke Tree; introduced trees include the Mango and the Pepper Tree.

The Sumacs (*Rhus*) are stoutly branching shrubs or small trees with pinnately compound leaves in most of the species, and white or greenish white flowers, each with five petals and five sepals. The common Staghorn Sumac of the Atlantic Coast is a shrubby tree with contorted branches covered with long brown hairs; each compound leaf is made up of eleven to thirty-one pairs of leaflets. The small yellowish flowers are produced in dense pyramidal clusters, which change to masses of reddish-brown fruits in autumn. An acid drink, somewhat like lemonade, is made from the fruits; while the bark and leaves are rich in tannins. Smooth Sumac is a shrub with shorter and softer hairs on the stems, and with leaves made up of the same number of leaflets; the flower clusters are a bright green. The Smooth Sumac ranges more to the west and south than the Staghorn Sumac. The Black or Dwarf Sumac has smaller leaves than either of the preceding species, each consisting of nine to twenty-one leaflets. It is a shrubby tree found in dry woods and fields from New England to Florida and west to the prairie states. None of these Sumacs have any poisonous properties.

In the central and western states we find several other species of *Rhus*. Squaw Bush is a low-growing shrub found from Missouri and Texas to the Pacific coast. Each compound leaf is made up of three leaflets which are wavy margined or lobed; the pale yellow flowers are borne in the typical dense cluster of the Sumacs, and produce red fruits. The pliant smaller branches were used in making baskets by the Indians of Washington and Oregon. In southern California there are the Laurel Sumac, growing to a height of ten feet, with simple evergreen and aromatic leaves and whitish fruits; the Lemonade Berry or Mahogany, a shrubby tree of the seacoast also with simple evergreen leaves; and the Sugar Bush of the inland drier hillsides.

Fragrant Sumac (*Schmalzia*) is a plant of another genus, found in dry woods from Florida to Indiana. It has three leaflets in each compound leaf, yellowish flowers and crimson hairy fruits.

There are several plants in the family with a resinous sap poisonous to the touch, grouped in the genus *Toxicodendron*—a long word meaning "poison tree". Among them we find the all-too-common Poison Ivy, the equally common Poison Oak and the rarer Poisoni Sumac. Poison Sumac is a shrubby tree of swampy habitats, found from New England to Florida and west to Minnesota. Its compound leaves are divided into seven to eleven leaflets, and the greenish flowers give rise to clusters of white fruits, thus differing from the common Smooth and Staghorn Sumacs, which have reddish-brown fruits. Poison Ivy is a familiar vine, widespread throughout the eastern states, west to Kansas. The plant climbs by means of aerial roots which enable it to cover walls, bushes and fences with a tangled growth. The glossy green compound leaves are made up of three leaflets, which may be entire or lobed or

toothed. The volatile oil produced by the plant is extremely irritating to the skin of some people and is the bane of campers and hikers in the eastern states. Poison Ivy can be recognized by the three-leaflet compound leaves; the harmless Woodbine, often confused with it, has five leaflets in its compound leaves. The Eastern Poison Oak is a shrub with hairy twigs and thick, lobed leaflets; it is common in dry woods along the eastern coastal plain south of New Jersey. The Western Poison Oak is one of the commonest shrubs in California; each compound leaf is made up of three leaflets, smaller than those of Poison Ivy and usually irregularly lobed or toothed. Both of these Poison Oaks have white fruits.

Poisonwood (*Metopium*) is a small tree of southern Florida, its compound leaves divided into seven to nine leaflets and the yellowish-green flowers borne in open clusters. The sap is a skin poison similar to that of the Poison Ivy and Poison Oak.

Two other native, but rather rare, members of the Simnec Family are the southern Smoke Tree and Pistachio. Smoke Trees (*Cotinus*) are shrubby trees of rocky hillsides, found from Alabama and Arkansas to Missouri. The under surface of their simple oval leaves are covered with silky white hairs; the green flowers are borne in plume-like clusters. Pistachio (*Pistacia*) is a small tree of the Rio Grande region of Texas, with compound leaves divided into nine to nineteen leaflets and naked red-tinted flowers in clusters, producing dark brown fleshy stone-fruits. The pistachio nut of commerce comes from a tree of the Orient and Mediterranean regions; the kernel is pale green or creamy yellow in color and has the oily flavor which makes it prized in cooking.

Two introduced trees of the family are the Mango and the California Pepper Tree. The Mango (*Mangifera*) is native to the Malay Archipelago, but widely cultivated throughout the tropics. The leaves are large and leathery, similar to those of the Magnolias; green or yellow flowers, borne in stiff erect clusters, produce the edible greenish stone-fruits whose taste has been variously described as being like that of an apricot, a peach and a pineapple. To dwellers of the tropics, where the Mango has been under cultivation for the last four thousand years, the fruit is of as great importance as the apple is to us. Mangoes have escaped from cultivation in Florida and are naturalized in the southern portion of the state. The Pepper Tree (*Schinus*), native of Peru, has become as typical a California street tree as has the Eucalyptus from Australia. Pepper Trees have the drooping habit of a Weeping Willow, the pendant stems bearing compound leaves with many narrow tapering leaflets. The clusters of inconspicuous yellowish flowers produce attractive masses of red berries.

The Buckthorn and Grape Families



Two families of plants which, in the United States, are vines, shrubs and small trees, are grouped by botanists in the Buckthorn Order; these are the Buckthorn or New Jersey Tea Family, and the Grape Family.

THE BUCKTHORN FAMILY

Six hundred species of shrubs and trees are found in the Buckthorn Family (*Rhamnaceæ*), which is widely distributed throughout the world. The members of this family have simple leaves and greenish flowers, each with four or five sepals and a similar number of petals.

The Buckthorn genus (*Rhamnus*) is represented in northeastern United States by the Alder-leaved Buckthorn, a low shrub found in the swamps of New England and New Jersey, extending west to the Pacific Northwest; the oval, rather acute leaves, are edged with fine teeth. In the southern and central states there are two common species, the Indian Cherry and the Narrow-leaved Buckthorn. Indian Cherry is a shrubby tree with elliptical leaves and flowers in small clusters, producing spherical black stone-fruits. It is common to moist shaded banks from Virginia to Texas. The Narrow-leaved Buckthorn is another shrubby tree, with more narrow and pointed leaves, living along river banks and on wet ground from Pennsylvania south and west to Texas and Nebraska. A shrub also known as Buckthorn, growing on the southern coastal plain, conspicuous for its spinescent branches and fragrant white flowers, belongs to another genus (*Sageretia*). The European Buckthorn, with rigid spine-like smaller stems, is cultivated as a hedge plant but often escapes and has become naturalized in some of our eastern states.

There are several other species of *Rhamnus* native to the western part of the United States. Red Berry is a common shrub of the California mountainsides, sometimes growing to be a medium-sized tree with spiny branches and leathery oval leaves edged with small teeth. The fruit consists of red berries in small clusters. Coffee Berry, also known as Yerba del Oso, also grows in the western part of the country in California and Oregon; it is a shrub with narrow oblong leaves, growing on hillsides and desert slopes. Its red berries turn black when ripe. Cascara Sagrada is a shrub or small tree which is found among the conifers in the forests of Oregon and Washington, south into northern California. The bark contains a cathartic substance sold as

cascara. This tree is one of the few important medicinal plants growing in the United States.

There are several other genera in the family of extremely local occurrence. Such are the Log Wood (*Condalia*), a small spiny tree of southwestern Texas; Red Ironwood (*Reynosia*) and Black Ironwood (*Krugiodendron*) of the coast and Keys of Florida; and Naked Wood (*Colubrina*) of the same region. Supple Jack (*Berchemia*) is a woody vine or sprawling shrub with inconspicuous greenish-yellow flowers in small clusters. The tough pliant stems give the plant its common name. It grows in various moist habitats from Virginia and Missouri southward to the Gulf of Mexico. The Jujube Tree (*Zizyphus*), a European shrub with red or black fruits, has become naturalized in some parts of Florida and the adjacent states.

The genus *Ceanothus* includes a great number of native plants, especially in the west. It is represented in the east by New Jersey Tea, in the south by Red Root, in the prairie states by Deer Brush and in the west by some thirty species including Wild Lilac, Blue Blossom and Snow Brush. All have small but attractive flowers, with five sepals and five hooded petals. New Jersey Tea is a low-growing shrub found on dry gravelly soils from Maine to Texas; the white flowers, with both petals and sepals colored alike, grow in dense clusters. The leaves are distinctly three-ribbed and more or less hairy; during the Revolution they were used as a tea substitute. Red Root is a shrub of the same size but with smaller leaves; it has similar clusters of white flowers. Red Root lives in the pinelands of Georgia, Florida and Louisiana. Deer Brush (also known as Tobacco Brush or Sticky Laurel) is a diffusely branching shrub with tough leathery leaves and a strong resinous or cinnamon odor; it grows on hillsides and mountain slopes from Montana and South Dakota west to the Pacific coast. The Snow Brush of the prairie states, (known as Oregon Tea farther west) is a taller shrub with reddish branches and more rounded leaves. On the hillsides and along the mountain canyons of California there grows the most colorful and abundant plant of the family, the California Lilac; this is a vigorous growing shrub with dense clusters of white, pale blue or lavender blossoms which often are produced in such abundance that they obscure the foliage and tint the hillsides with a bluish haze. Closely related species include the Blue Blossom which ranges north into Oregon and has similar flower clusters; and Snow Brush with white flowers, a plant of the open pine woods of California and Oregon.

THE GRAPE FAMILY

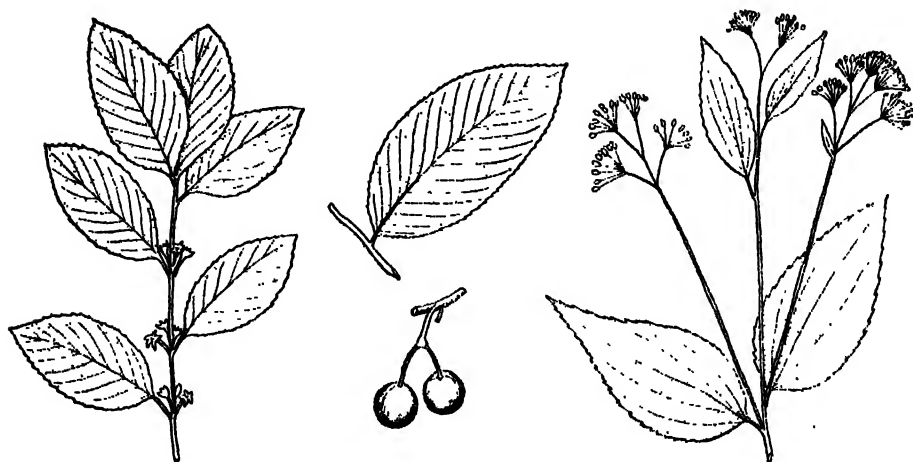
The members of the Grape Family (*Vitaceae*) are woody vines, often attaining a length of fifty or sixty feet and climbing by means of tendrils which in reality are modified small branches. The leaves may be simple or compound, and the flowers, consisting of four or five sepals and a similar number of petals, grow in clusters in the axils of the leaves. The fruit is a large juicy berry, edible in many of the species and long used by mankind in the making of wine. In the family we find Woodbine, Pepper Vine, Possum Grape, Muscadine Grape and the various true Grapes.

Woodbine or Virginia Creeper (*Parthenocissus*) is an attractive vine with compound leaves, divided into five-toothed and pointed leaflets; the tendrils end in little adhesive discs useful to the vine in climbing. This is a familiar plant in the east, clambering over fences and stone walls where it forms a drapery of glossy green in

summer and colorful masses of rich red in autumn. The small green flower clusters produce blue berries which are inedible. Woodbine ranges throughout the eastern and central states.

Pepper Vine (*Ampelopsis*) is a vine with fewer tendrils and simple or pinnate leaves, growing along river banks from Virginia southward and westward to the central states; greenish-blue berries are produced in flat-topped clusters.

Possum Grape or Marine Ivy (*Cissus*) has somewhat fleshy, simple or compound leaves; this vine is common on sandy shores from Florida to Texas and Kansas. The small black berries are not edible.



RHAMNACEAE

Alder-leaved Buckthorn, Cascara (leaf and fruit), New Jersey Tea.

Scuppernongs or Muscadine Grapes (*Muscadina*) differ from all the preceding vines, as well as from the true Grapes, by having simple instead of forked tendrils and in the smooth rather than shredded bark. The simple leaves are usually coarsely toothed or divided into angular lobes; minute green flowers produce dull purple berries which have a tough skin. Scuppernong is a vine of swamps and sandy banks, ranging from our southeastern states west into Texas and Kansas.

All of the native and introduced varieties of true grapes belong to the genus *Vitis*, which is the old classical name for the grape. They are vines with shredding bark, forked tendrils and large usually palmately lobed leaves; minute green flowers give rise to clusters of juicy berries which vary in color from black to amber. Most of the species are native to our eastern and southern states, only a few occurring on the prairies and in the far west. On the Pacific Coast there are two species. The California Wild Grape, with sinuous stems often fifty or sixty feet long, is common along streams in the mountains of California and Oregon, where it frequently covers oaks and cottonwoods with such a tangled growth that the mass of foliage kills the trees. The flowers are unusually fragrant and produce purple fruits. The Desert Grape is a smaller vine of southern California, producing smaller and blacker berries.

Four of the common eastern species are characterized by leaves which are a

smooth green on the under side. The Sand or Sugar Grape is a low bushy plant of river banks and hillsides in Virginia and southward; the rather small leaves are a glossy green and the stems frequently lack tendrils. The purplish black fruit of the Sand Grape has a somewhat pleasant taste. The Frost or Chicken Grape is more of a vine, with leaves which are longer than they are broad, indistinctly divided into three lobes. The black fruits ripen only after the first frosts of autumn. Frost Grapes grow along stream banks in thickets from New York south to the Gulf of Mexico and west to the Great Lakes; they are sturdy and vigorous growing vines with trunks often a foot or more in diameter and climbing like lianes to the tops of the tallest trees.



RHAMNACEAE

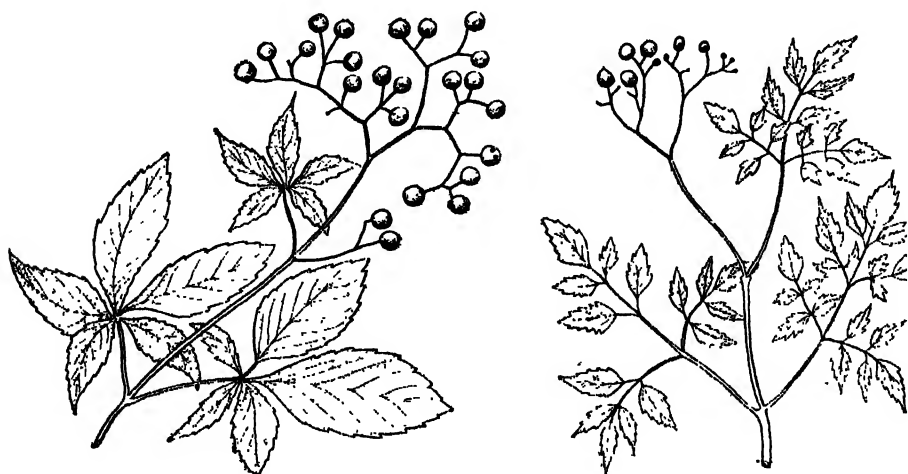
Logwood and Red Berry.

The Riverbank Grape is another high-climbing species of rock stream banks, inhabiting an extensive range from the Atlantic Coast west to the Rocky Mountain. The leaves are bright green and irregularly lobed. Sweet-scented flower clusters give rise to purplish-black sour fruits which are covered with a blue bloom. This is the commonest grape of the northern states west of New England. The Cat or Red Grape, with deeply three- to five-lobed leaves, grows in sandy and rocky thickets from Iowa and Illinois south to the Gulf of Mexico; it is characterized by bright red branches and a black fruit without the usual bloom.

Other species of grapes have leaves which are pale green or rusty colored and hairy on their under surface. The Blue Grape or Summer Grape found in rocky woods in our northeastern states, is a high climbing vine with three- to five-lobed leaves and sour purple fruit. The Downy Grape is a species of the central states, found growing along streams in the woods from the Ozarks east to Florida and west to Texas; its leaves may be entire or three-lobed, with a conspicuous triangular apex and an ashy-gray color to the cobwebby undersurface. The black fruits ripen and become sweet only after the frosts. The Summer or Pigeon Grape differs from the Downy Grape in the rusty red hairy covering to the undersurface of the leaves; it is a tall climbing vine with black berries which vary in taste. This species grows in rocky

thickets over a wide area, from the Atlantic Coast to Kansas and Iowa. The most valuable of our native grapes is the Fox Grape of New England, which is also found southward in the Alleghenies as far as Georgia. The thick and strongly veined leaves are rusty woolly on the undersurface and slightly three-lobed; the fruits, relatively large when compared with those of the other native species, have a sweet musky taste and vary in color from purple to red and amber. The Fox Grape is the parent of such well-known varieties as the Concord, Catawba, Niagara and Delaware Grapes.

Grapes are among the oldest cultivated plants, grape seeds having been found in three-thousand-year old Egyptian tombs and in ruins of the Swiss lake dwellers. Grapes are predominantly north temperate region plants, and are especially abundant



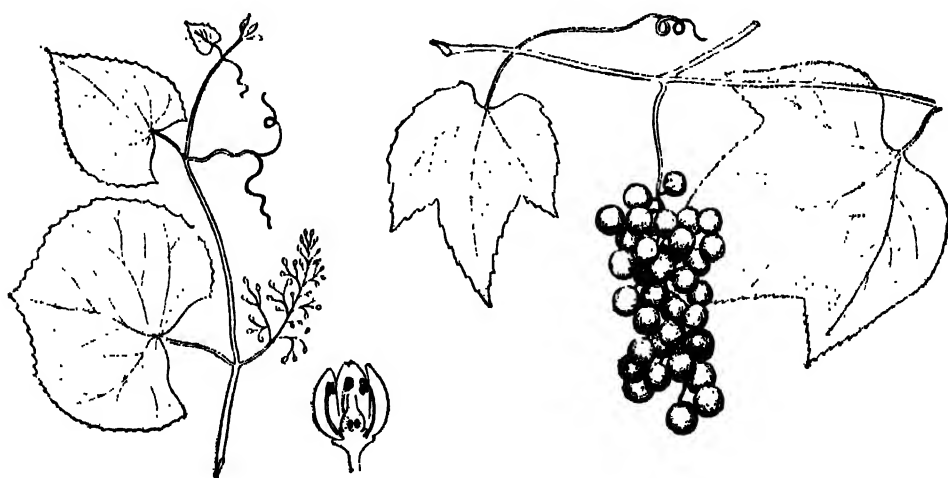
VITACEAE

Virginia Creeper and Pepper Vine.

in the United States. The European Wine Grape was originally native to the Caspian or Caucasian region; it is not hardy in the United States except in the warmer parts of California and other southern and southwestern states. The early colonists tried, unsuccessfully, to grow Wine Grapes in Virginia. A variety of this European Grape, however, was brought with greater success to Mexico by the Spaniards, and from there brought to the California missions where it was grown both as a table grape and for making sherry wine. For a long time this so-called Mission Grape was the only variety grown in California; it is still the common grape of vineyards in Mexico and some of our southwestern states. But other varieties of the European Wine Grape have since been introduced and these are used almost exclusively in the grape growing regions of California. Most commonly, the Tokay variety is grown for eating, the Muscat for raisins and the Zinfandel for wine.

Grapes were probably used in the making of wine long before they were cultivated, and this is still their chief use. Second in importance is the production of raisins, and third their use as a fresh fruit and a source of grape juice. The only native grape used for any of these purposes, commercially, is the Fox Grape, which in some in-

stances has been crossed with the European Wine Grape to give more hardy and edible varieties. Best known descendant of the Fox Grape is the popular Concord variety which originated on the farm of Ephraim Bull in Concord, Massachusetts; the town has erected a monument commemorating the event. Concord grapes are used as a fresh fruit, in making grape juice, and wine. The chief grape growing areas of the United States are New York and Ohio (around the lakes and rivers), and California. The growing of grapes is an old California industry; as long ago as 1860 there were over six thousand acres of vineyards cultivated chiefly for making white and red wines. This has grown to over four hundred thousand acres, distributed throughout the state although the largest of the vineyards are in southern California adjacent to the



VITACEAE

Fox Grape and Blue Grape.

citrous groves. In 1912 the California vineyards produced almost fifty million gallons of wine. The California vineyards present a far different picture from that of the usual eastern vineyard or terraced European one. The plants are cut back every year, forming short stout gnarled trunks which look black and dead during the resting season. In spring a few long shoots are permitted to grow out horizontally and trail over wires up to a height of about four feet; on these low vines the grape clusters are borne.

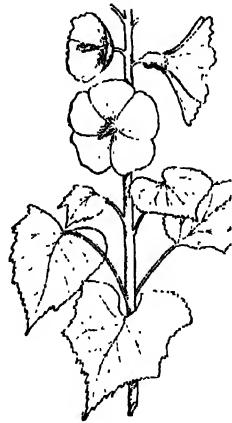
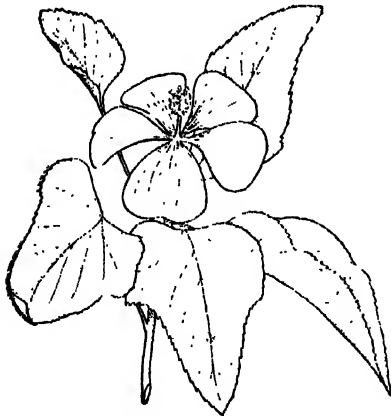
An important accessory product of the vineyards are raisins; raisins are for the most part Muscat grapes which are gathered in trays and sun-dried for a period varying from a week to a month. Twenty pounds of grapes yield about five pounds of raisins. The curing process requires hot dry weather; in case of rain or a damp spell, the trays have to be collected and protected from the moisture. Thousands of pounds of raisins are produced by California annually.

CHAPTER XXX

The Mallow Family and Its Relatives



IN THIS chapter we shall consider three families of related plants, some of which include common wild flowers and their more showy garden relatives, others native trees and plants important as a source of fibers. The Mallow Family, the Linden Family and the Kapok Family are all included in the Mallow Order (*Malvales*);



MALVACEAE

Marsh Mallow and Hollyhock.

another family, the Cacao Family, is reserved for the next chapter which deals with the beverage plants.

THE MALLOW FAMILY

The Mallow Family (*Malvaceae*) includes about a thousand species of herbs and shrubs—some of which become trees in the tropics—which are mainly warm temperate and tropical plants. Their leaves are simple and usually palmately lobed; but the most characteristic feature of the family is the large showy flower, often six to eight inches in diameter. The calyx is usually made up of five partly fused sepals, often surrounded at its base by a number of small leaf-like bracts. The five large petals surround a central column which is the fused mass of stamens, often brightly colored and prominent; within this column is the pistil. The fruit is a capsule, some-

times large as in the Cotton Plant. There are numerous kinds of native Mallows, especially in the South and West; many of the introduced garden varieties have escaped and become naturalized in some states. In addition there are the Flowering Maples, the Rose Mallows or Hibiscus, Hollyhock and Cotton.

The True Mallows (*Malva*), with lobed or dissected leaves, include thirty species native to Europe, northern Africa and Asia; where they occur in the United States they have escaped from cultivation. The mucilaginous leaves and flowers of some of the species have medicinal value; though the marshmallow of commerce comes from the root of another genus (*Althaea*) common to the marshes of Europe. Dwarf Mal-



MALVACEAE

Musk Mallow and Clustered Poppy Mallow.

low, with slender trailing stems, rounded leaves and pale lilac flowers, is found throughout eastern and western United States. Cheeseweed is more erect and wide-spreading, with shallowly lobed leaves and pink or lilac petals; it grows along roadsides and in waste places from Florida to Texas, north into the central states as well as westward. Musk Mallow has five-parted and deeply lobed leaves, a hairy calyx and rose or white flowers. It has become established in various states from the Atlantic to the Pacific coast.

The False Mallows (*Malvastrum*) include seventy-five plants, either herbaceous or shrubby, found wild as well as under cultivation. The Yellow False Mallow is an annual with narrowly elliptical leaves and yellow flowers, thriving on dry rocky hillsides from Alabama northward into Kansas. Several other species occur native in the Gulf region from Florida to Texas, all with yellow or orange flowers. Of the nineteen species growing on the Pacific coast, we might mention the attractive Desert Five Spot, with its hairy rounded leaves and rose-pink petals, each marked with a darker spot at its base; this is a plant of the California deserts and adjacent Arizona and Nevada. The Bush Mallow is a tall shrubby species with pink flowers, growing on the hillsides of southern California. Several of the garden varieties have white petals with purplish spots or "eyes" at their base.

The Poppy Mallows (*Callirrhoe*) include eight American species with lobed or dissected leaves. The Clustered Poppy Mallow, with deep purple flowers, is a plant of dry woods from Alabama and Texas northward. Other related species with purple, violet, crimson or white flowers inhabit the dry plains and prairies.

The Wax Mallows (*Malvastrum*) are tropical plants of which one species reaches our Gulf coast region; they are tall perennials with rounded three-lobed leaves and vermilion flowers. The Achania Wax Mallow of South America is a favorite house and conservatory plant, because of the unusual scarlet flowers which remain partly closed.

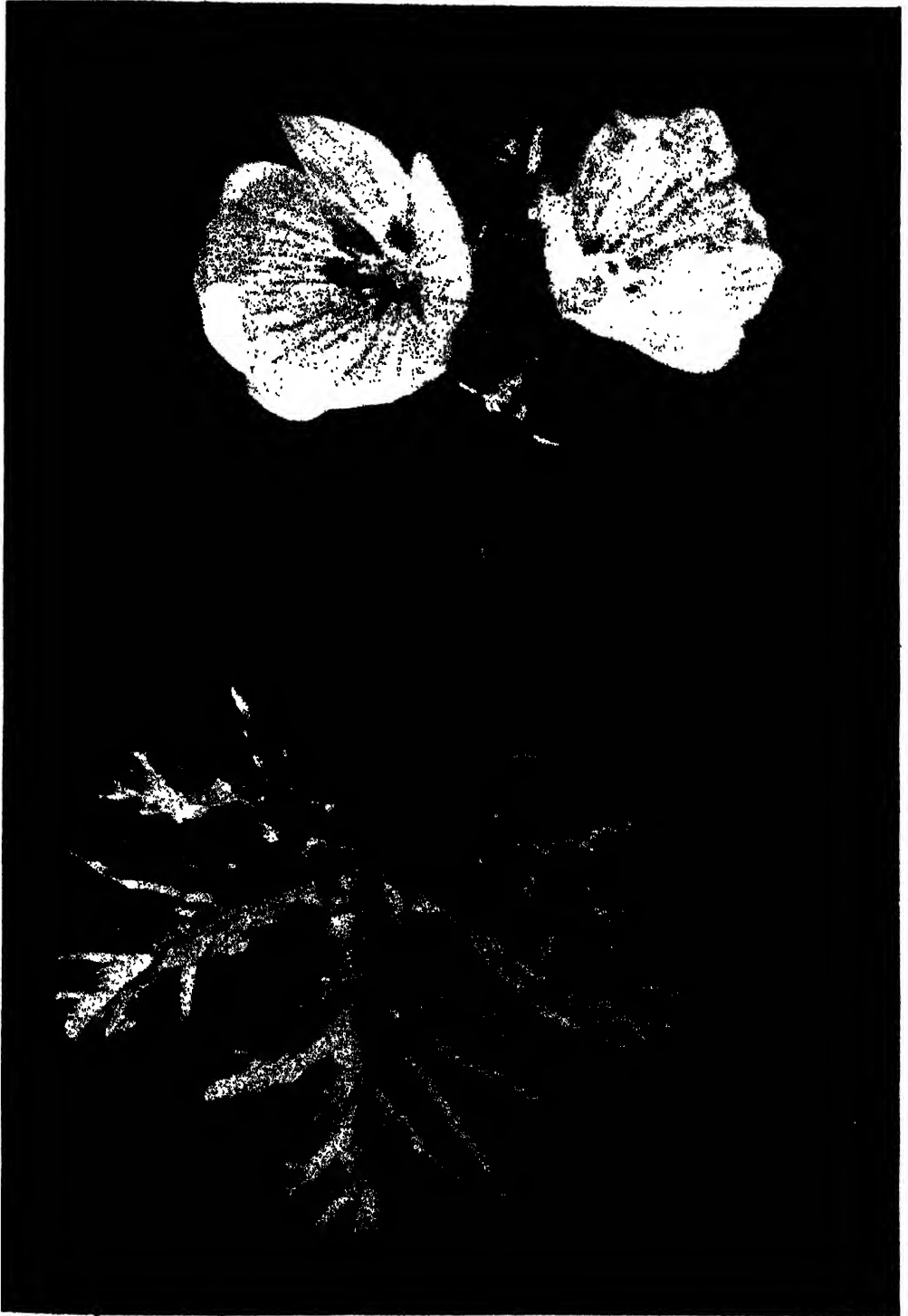


MALVACEAE

Desert Hollyhock and Checker Bloom.

The Flowering Maples (*Aibutilon*) get their name from the similarity of their leaves to those of the Maples; they are also known as Chinese Bell Flowers because the pendant flowers, with their tubular calyx, never open wide. Various cultivated species come from China, Abyssinia, and South America. A Brazilian species has a long bright red calyx and lemon yellow petals with a column of protruding stamens. Some of the tropical members of the genus yield fibers of commercial importance, known as China jute. The Asiatic Indian Mallow or Velvet Leaf is such a species, with velvety foliage and yellow flowers; it has become naturalized in waste places from New England to Florida and Texas.

Virginia Mallow (*Sida*) has palmately lobed leaves and flowers with triangular calyx lobes and white petals; it grows along rocky banks and river margins from Ohio to Virginia. There are a hundred other widely distributed species in various countries, many of them with fibrous bark. Prickly Sida is a yellow-flowered plant of waste places throughout eastern and central United States. A few other species, some native and some naturalized, occur in the southeastern states. In alkali habitats from Texas west to the Pacific Coast we find the Alkali Mallow, a prostrate low-growing plant with gray-white stems and foliage, and pale yellow or cream-colored flowers.



The True Mallows (*Malva*) are European or Asiatic plants which have become naturalized in various parts of the United States. Eaton, New York.

It often becomes a troublesome weed in orchards, being then known as White Weed.

The Globe Mallows (*Sphaeralcea*) of the midwestern states have pink or brick-red flowers and lobed leaves, three species inhabit the dry plains from Texas to Iowa and Kansas. In our southwestern deserts grows a near relative, the Desert Hollyhock or Apricot Mallow with brick-red flowers, solitary or in axillary clusters, and prominently veined thick leaves. Other western Mallows include the Wild Hollyhock or Maple-leaved Mallow (*Sphaeralcea*) of stream margins from the Dakotas to the Pacific Coast, the large pink or white flowers are often clustered at the summit of the plant. There is also the Checker Bloom (*Sidalcea*) with terminal



MALVACEAE

Flowering Maple and Okra

cylindrical clusters of rose or purple flowers growing on open hillsides of California, a dozen related species are found in the meadows and mountain valleys of that state.

Okra or Gumbo (*Abelmoschus*) is a large coarse plant native to Africa which has escaped from cultivation in the Gulf region, this member of the Mallow Family is grown for its mucilaginous pods which are used in soups and stews.

The most strikingly flowered genus of the family is the Rose Mallow (*Hibiscus*), of which we have several native species. The Swamp Rose Mallow is a vigorous growing plant, reaching a height of eight feet in the coastal marshes from New England to Texas, as well as in swampy habitats west along the Great Lakes; its light rose-pink flowers are often seven inches in diameter. The Crimson-eye Rose Mallow grows in coastal marshes also, from New Jersey southward, it has white flowers marked with a crimson or purple center. There are seven other species occurring in swamps and wet habitats of our southeastern states. In the West, there are the California Rose Mallow with white or pink flowers, marked with a deep crimson center, living in the river swamps of California, and the Pale Face, a species with lavender to white blossoms, marked with purple in the center, growing on the southwestern deserts and west to Texas. Because of the brilliantly colored and showy flowers, many foreign species as well as native ones are garden favorites. Of the two

hundred known species, many can be found in our American gardens; in the South they form outdoor shrubs often attaining the size of trees. Chinese Hibiscus is a popular variety with brilliant red flowers four to five inches in diameter and a projecting central column of scarlet stamens and pistil. Sunset Hibiscus, or Queen of the Summer, is a species from China and Japan with pale yellow or white large flowers; each petal has a purple "eye" at its base. Rose of Sharon has bell-shaped rather small flowers, varying in color from purple and violet to pink and white; its native



MALVACEAE (*Hibiscus*)

Chinese Hibiscus (*upper left*), Swamp Rose Mallow (*lower left*), Rose of Sharon (*right*).

home is Asia. The Trailing Hollyhock, or Flower-of-an-hour, from Africa is an interesting plant with yellow or white flowers which open in the sun and close in the shade.

Among the cultivated flowers, none are so completely associated with old-fashioned gardens as the Hollyhock (*Althaea*). This member of the Mallow Family, native of China, was already in cultivation in that country when discovered by Europeans. The wild forms are usually rose or pink flowered; cultivated varieties occur in a number of shades, in both single- and double-flowered forms.

There is no other single plant which has so influenced civilization and economic history as the Cotton Plant (*Gossypium*). The name is derived from the French "coton", which in turn comes from the Arabic "qutun". There are thirty or forty

species, native to the warmer portions of the whole world. It is said to be the only plant of any economic importance which was cultivated independently in both the Old and the New World. Cotton cloth has been found in ruins in India which are five thousand years old; the plant was not, however, cultivated in the Mediterranean region until the beginning of the Christian Era and it was not until the Middle Ages that the true value of cotton as a textile fiber became known. In the New World, Columbus found the American aborigines using cotton cloth; cotton was grown in Mexico, Central and South America when the Spaniards arrived. When Coronado reached the region which now is Arizona and New Mexico, he found cotton already under cultivation there. It ranks as the most important plant fiber, and has played



MALVACEAE (*Gossypium*)

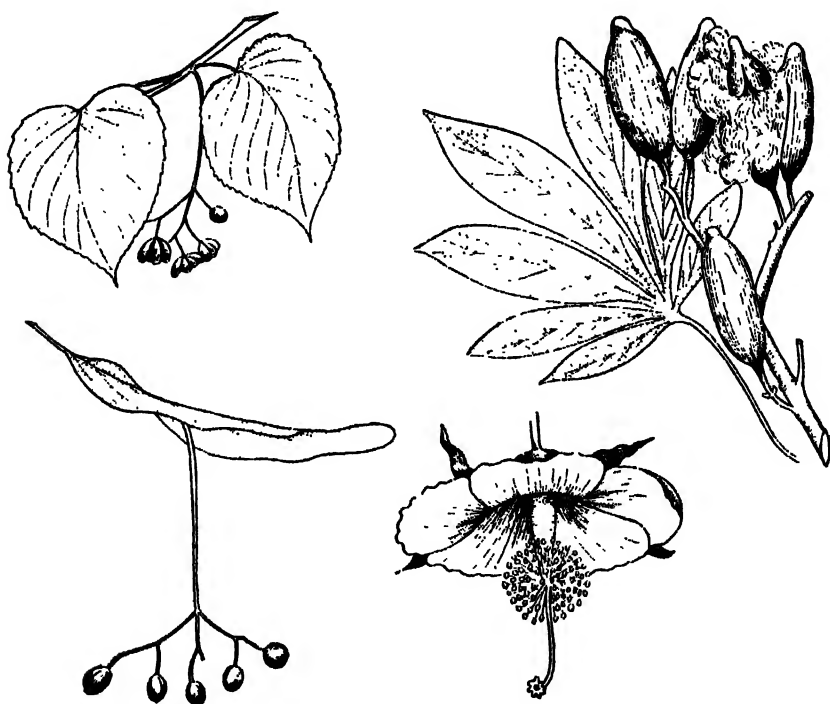
Upland Cotton: section of flower, general habit of plant, and fruit or boll.

an important role in bringing on the Industrial Revolution which had such far-reaching effects upon civilization.

Cotton plants are herbaceous annuals when cultivated in temperate countries; in the warmer portions of the continents, the wild species are often shrubby perennials and attain the size of trees. The leaves are heart-shaped and usually three- to seven-lobed; the flowers vary in color in the different species. Upland Cotton has white Mallow-like flowers which turn pink in a day or two; Sea Island Cotton has yellow flowers. The fruiting capsule or boll contains seeds which are covered with long white unicellular hairs—the fibers which, because of their natural twist, can be woven into threads and yarns. There are six commonly grown species. The longest and silkiest fibers come from Sea Island Cotton, native to the West Indies and first grown on the islands and coastal areas off Georgia, South Carolina and Florida. The destructive Boll Weevil pest made growing this species unprofitable in the United States, so that little of the American crop consists of this variety. Egyptian Cotton has a fiber intermediate in length between the Sea Island and the Upland species; it is grown under irrigation in Arizona and California, where the well-known Pima and Yuma varieties are produced. Most of the American cotton is secured from

Upland Cotton, which is hardier than either of the preceding. Old World species include Levant Cotton, cultivated in western Asia and southern Europe; Indian Cotton, the common crop of India; and the Chinese and Japanese Cottons.

Since the fibers of cotton are very firmly attached to the seeds, as long as they were removed by hand, cotton was not widely used. After the invention of the cotton gin in 1792, cotton growing received a great impetus. Today about two thirds of the world's supply comes from the United States; other cotton countries, in order of importance, being India, China, Egypt and Russia. Cotton is grown in a surprising number of states in this country—nineteen states considering it a leading crop. Most of the cotton is grown in a vast area south of an imaginary thirteen hundred mile



TILIACEAE

Linden (*left*) leaves, flowers and fruit · Baobab flower; Kapok tree, leaves and fruit (*upper right*).

line from Virginia to Texas; it is also grown in California, Arizona and New Mexico. At first the cotton fibers were considered the only important part of the cotton plant; as the crop increased, the disposal of the useless seeds became quite a problem. Laws were passed in 1857 prohibiting the dumping of cotton seeds in creeks and rivers. But in the next twenty years methods for obtaining the valuable oil from the cotton seeds were improved, until today cottonseed oil is one of the important products of the cotton crop. Cottonseed oil is used in making margarine butter substitutes, table oils, and soaps; the "cake" left after the removal of the oil is used as cattle food. Three quarters of a million tons of cottonseed oil are produced

annually. Another important aspect of the cotton plant is its increasing value as a source of cellulose-acetate products such as rayon "silks." Cotton and wood pulp are both used to procure pure cellulose, which in solution is squirted through holes in a metal plate to make continuous "threads" which harden quickly to form the lustrous basis of the increasingly popular rayon products.

THE LINDEN FAMILY

The Linden Family (*Tiliaceae*) has only one genus, the Linden, native to the United States, though it includes over three hundred species of temperate and tropical plants. These are for the most part shrubs or trees with simple deciduous leaves and with small creamy-white or yellow flowers grouped in clusters. In many species the bark is fibrous enough to be of commercial value. Another genus, the Jute Plants, have escaped from cultivation and become naturalized in the Gulf states.

Jute (*Corchorus*) is an annual plant, six to ten feet in height, with serrate leaves and small yellow flowers. Several of the Central American and South American species have become naturalized in Florida and adjacent states, where they are known as Jew's Mallows. The Jute of commerce is a long fiber—six to ten feet in length—secured from the bark of several species native to India. Jute fibers are inferior to those of flax or hemp because a varying diameter of the fiber cell causes unequal strength in different parts of the fiber, in addition they are too brittle and woody to be woven by the ordinary methods used for other plant fibers. Jute fibers are separated by retting under water, and the dried fibers are then baled and shipped. Jute is used in making cordage, sacking, matting, paper, cloth, and Brussels and Wilton carpets. The Department of Agriculture attempted the introduction of this fiber plant into the United States, setting out plants from Texas to South Carolina in 1870. As yet, however, our crop is negligible, over a hundred million pounds are imported annually.

The Lindens (*Tilia*), also known as Basswoods, are represented in the United States by fifteen species, all occurring east of the Rocky Mountains and most common in the southeastern states. These are all trees with deciduous, heart-shaped and toothed leaves. The clusters of flowers, and later the small fruits, are attached to a leaf-like bract which supports the fruits when they separate from the parent tree and acts as a plane aiding wind dispersal. The flowers are unusually fragrant and yield large quantities of nectar, utilized by bees in making a delicate tasting honey. The inner bark of Lindens is fibrous, and sometimes used for making matting, cordage and fish nets. The wood is pale colored, light in weight and straight grained, it is used for interior finish, articles of woodenware, paper pulp and sounding boards of pianos. The American Linden is a good-sized tree, often 100 feet tall, of rich moist woods from New England west through the Great Lakes area to Nebraska, south to Ohio and Kentucky. The leaves are smooth, with tufts of hairs in their axils where they join the branches. Another species, found from New England to North Carolina and Missouri, has more hairy leaves and less conspicuous tufts of hairs in the leaf axils. All the other Lindens are small- or medium-sized trees of Texas, the Gulf states, Florida and the coastal plain as far north as Virginia.

THE KAPOK FAMILY

One family of tropical trees, known to botanists as the Bombax or Kapok Family (*Bombacaceae*), is unusually interesting because the barrel-like trunks of some of the species attain an enormous size. The Baobab Tree (*Adansonia*) of Africa and Australia, often cultivated in India and South America, has the most massive trunk of any known tree; the trunk, when it is hollowed out, serves the natives as a home and provides them with their dug-out canoes. Kapok, or silk-cotton, is a straight fiber which grows as hairs lining the pods of the Silk-cotton Tree (*Ceiba*), native to the West Indies and cultivated extensively in Java. The silky hairs are resilient, buoyant and water-resisting; hence they are excellent for life-preservers and mattresses. Kapok oil is sometimes used in the manufacture of soap. In the making of mattresses and life-preservers, the United States imports some ten thousand tons annually.

CHAPTER XXXI

The Beverage Plants



MAN must drink as well as eat, and the obliging plant kingdom has furnished him with a great variety of alcoholic and non-alcoholic beverages to suit every taste. Of the former, we have already become acquainted with Hops (Chapter 13) and the importance of Yeast (Chapter 5) in the making of wine from grapes (Chapter 29). A great number of our common non-alcoholic beverages and 'soft' drinks are juices of fruits, such as cider, orangeade and lemonade, others are flavored with root and foliage extracts. But the most important is that great trio of table beverages (tea, coffee and cocoa) which are as essential a part of our meals as the meat and vegetables. These ancient beverages come from plants in three different families, widely separated geographically. Coffee is in the Madder Family, its botanical relatives, in the Madder Order (*Rubiales*), being the Honeysuckles and Teasels. Tea is a plant in the Tea Family, belonging with the Violets and Begonias in the order known as the *Paricetals*. Cocoa and chocolate come from trees in the Cacao Family which is closely related to the plants discussed in the preceding chapter. Each of these three comes from one of the ancient centers of agriculture, tea from the Orient, coffee from Africa and cocoa from the home of the Aztecs in tropical America.

THE CACAO FAMILY

The Cacao Family (*Sterculiaceae*) includes about seven hundred species of trees and shrubs which are chiefly tropical and sub-tropical in their range. They have simple, rarely compound, leaves and flowers usually with a five-parted calyx and five petals. The stamens, like those of the Mallow Family, are united into a columnar tube. In addition to the important Cacao Tree (*Theobroma*), the family is represented in the tropics by the Cola Tree (*Cola*) of Africa, cultivated in the West Indies. The seeds of the Cola Tree are the "nuts" used medicinally and for a well-known soft drink. In the United States its representatives are two western shrubs. Flannel Bush (*Fremontia*) named after General John C. Fremont, explorer of the far west and discoverer of the plant, is also popularly known as California Shippery Elm because the bark is used as a substitute for the bark of that tree. Flannel Bush is an evergreen shrub with leaves which are grayish-white on their undersurface and

flowers which lack petals, the five-parted calyx being yellow and petal-like. It grows to a height of ten feet on the slopes of the California mountains. Another, related genus (*Ayenia*) is a low-growing shrub of the southern California mountains, with brownish flowers, made up of both petals and sepals.

When Linnaeus, the great Swedish botanist who classified and named many of the plants of the world, first tasted the then unusual beverage chocolate, he exclaimed, "Ah, Tea for the Gods!" Later he gave the Cacao Tree the scientific name of *Theobroma* which is the Greek equivalent of his exclamation. There are about a dozen small trees in the genus, all native to tropical America and characterized by simple leathery leaves and small pink flowers; these are borne directly on the tree trunk, and thus the fruit pods are produced in the same unusual fashion. Each tree bears about twenty large pods, filled with almond-like seeds in a pulp; these seeds are the "beans" used in making cocoa and chocolate.

The Cacao Tree was under cultivation when the Spaniards came to Mexico and Central America; the original home may have been northern South America. The beverage made from the cacao seeds was highly prized by the Aztecs and Mexicans, who called it "chocolatl"; this was a cold frothy drink, seasoned with peppers and spices. The Spaniards brought "chocolatl" to Europe, improving it (we think) by adding sugar; there its use began in about 1600, but it was so expensive that only the wealthy could afford it. The English further "improved" it by adding milk. Swank chocolate houses which later became famous clubs, sprang up in London and Amsterdam where the aristocrats could come and sip this "tea of the Gods".

At first Cacao Trees were grown only in the New World, especially in Brazil, Ecuador, Trinidad and San Domingo. But at present at least half of the world's supply comes from Africa (the Gold Coast, Nigeria, St. Thomas), Java and Ceylon. The greatest consuming countries are the United States (leading with a per capita annual consumption of about two pounds), Germany, Holland and Great Britain.

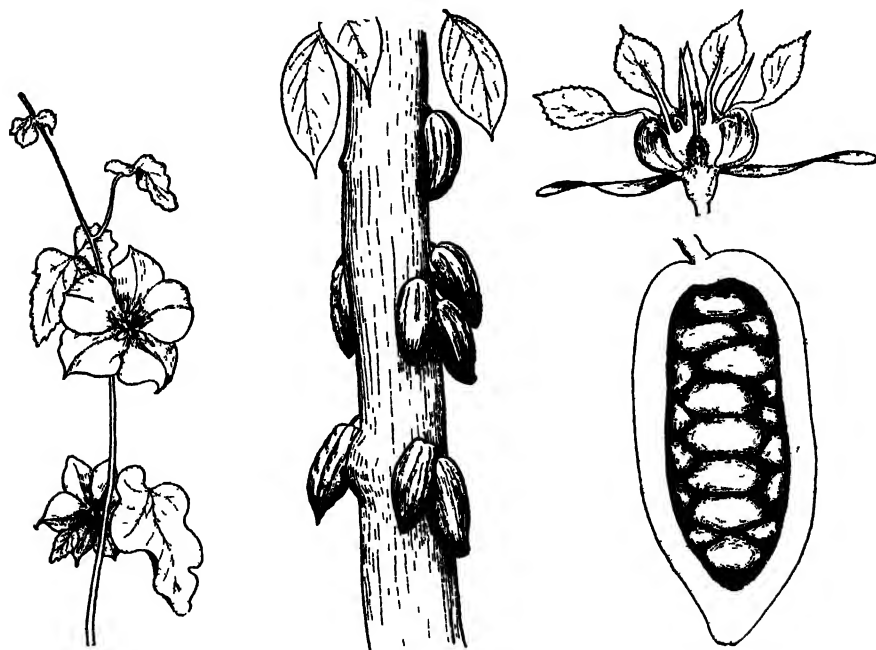
Cacao Trees are strictly tropical, requiring high temperatures for their growth. Four or five year old trees begin bearing the pods on their trunks; these are cut off and the seeds removed from the pulp, placed in boxes or in heaps covered with sand and allowed to ferment. Fermentation involves decomposition of the mucilaginous seed coats. After fermentation and subsequent washing, the seeds are dried, then roasted, shelled and broken into pieces known as "nibs". Now they are ready to be made into either cocoa or chocolate. If, when the nibs are sent through presses, the oily cocoa butter is removed, the ground and dried product is cocoa. If chocolate is to be made, the cocoa butter is left in, sometimes even more is added, as well as sugar. Both products contain various volatile flavoring substances and a drug, theobromine, related to caffeine. Milk chocolate in cakes for eating was introduced by a Swiss manufacturer in 1876. Cocoa butter is an important adjunct of the cocoa and chocolate business; it is widely used in making confectionery, cosmetics, ointments and soaps.

THE TEA FAMILY

The Tea Family (*Theaceae*) includes two or three hundred species which are vines, shrubs or trees of tropical and warm temperate regions; they often have showy flowers with five sepals and five petals. Our few native members of the family are all found in the southeastern states—Loblolly Bay, Silky Camellia and Mountain Camellia. In

outdoor cultivation, especially in the South and West, is the True Camellia, a native of southern Asia. Tea itself is an Old World plant widely cultivated in the tropics.

Loblolly Bay (*Gordonia*) is a large tree with evergreen leaves, much like those of the Magnolia, growing in the swamps and along the bays of the coastal plain from North Carolina to Louisiana. The tree bears large fragrant flowers on stout reddish stems, each flower consists of five sepals and five white petals. Silky Camellia (*Stuartia*) is a shrub whose flowers have white petals and purple stamens, it inhabits wooded hillsides along the coastal plain from Virginia to Louisiana. Re-



STERCULIACEAE

Flannel Bush (*left*), Ciclo plant—trunk with fruits, section of flower and section of pod

stricted to the higher areas of the Blue Ridge and Appalachian Mountains is the Mountain Camellia (*Malachodendron*), a white-flowering shrub of woodland stream banks.

The True Camellias (*Camellia*) are showy-flowered shrubs and trees named after a Jesuit, George Camellus, who travelled widely in Asia during the seventeenth century. Camellias have handsome evergreen foliage and bear large red, pink or white flowers. In many varieties some of the stamens are transformed into additional smaller petals, making double flowers. Camellias grow well on the sandy pineland soil of our southeastern states, provided they are protected from too much direct sunlight.

The Tea Plant (*Thea*) is a shrub or small tree with a dense head of leathery toothed leaves, and with white or pink flowers bearing conspicuous stamen clusters.

The word "tea" is an anglicized version of the Chinese dialect "té". The origin of the Tea Plant is buried in the obscurity of Chinese legends; it was cultivated by 2500 B.C., originally for medicinal purposes. Its native home may have been in northern India. By the ninth century its cultivation and use had spread to Japan, and at that time it already was the most common Oriental beverage. Explorers brought tea back to Great Britain and Holland in the sixteenth century, the first teas coming from Java. Soon it was being served in London coffee houses; but, selling at sixty shillings a pound, was a luxury only the wealthy could afford. Tea drinking was a habit



THEACEAE

Tea (*left*), Loblolly Bay (*upper right*) and Camellia (*lower right*).

brought by the early colonists to the New World; and perhaps no other plant is so intimately bound up with the traditional events preceding the Revolution. The four-o'clock tea habit of the British dates back only to the middle of the last century. The great consumer of tea is England, where each person uses an average of nine pounds annually; other countries using tea liberally are Canada, Australia, Russia and the United States. We average about a pound per person each year.

The great tea exporting countries of the world are India and Ceylon, which grow about half of the entire tea crop. Most of the Chinese tea is consumed at home. Other tea producing countries include the Dutch East Indies, Japan and Formosa. In-

roduced into the Carolinas, tea growing was a failure because of the scarcity of cheap labor. The finest grades of tea come from picking only the youngest and most tender leaves. For all grades of tea, the leaves are slightly bruised before being further treated. If green teas, such as the Oolong and Souchong varieties, are desired, the bruised leaves are dried in firing machines and are then ready to be packed and shipped. In making black teas such as the Orange Pekoe, which comes from Ceylon and India, the bruised leaves are allowed to dry slowly enough to permit fermentation to take place; after fermentation, the blackened leaves are fired as in the case of the green teas. The tea leaves contain volatile oils, alkaloids, and tannins; the volatile oils lend the aromatic fragrance to the beverage and the alkaloid drug theine gives the stimulating effect. Both of these are more soluble than the bitter tannins, which are removed only when the leaves are boiled.

Many other "teas" are made from various plant leaves; the early colonists tried various tea substitutes, as we have noted in the case of New Jersey Tea. A favorite beverage throughout most of South America is Yerba Maté, made from the leaves of a Holly which also contains theine. The tea, prepared by pouring boiling water over the leaves, adding sugar or lemon juice, is sucked through a hollow tube provided with a strainer at one end. Maté plantations are found in northern Argentine.

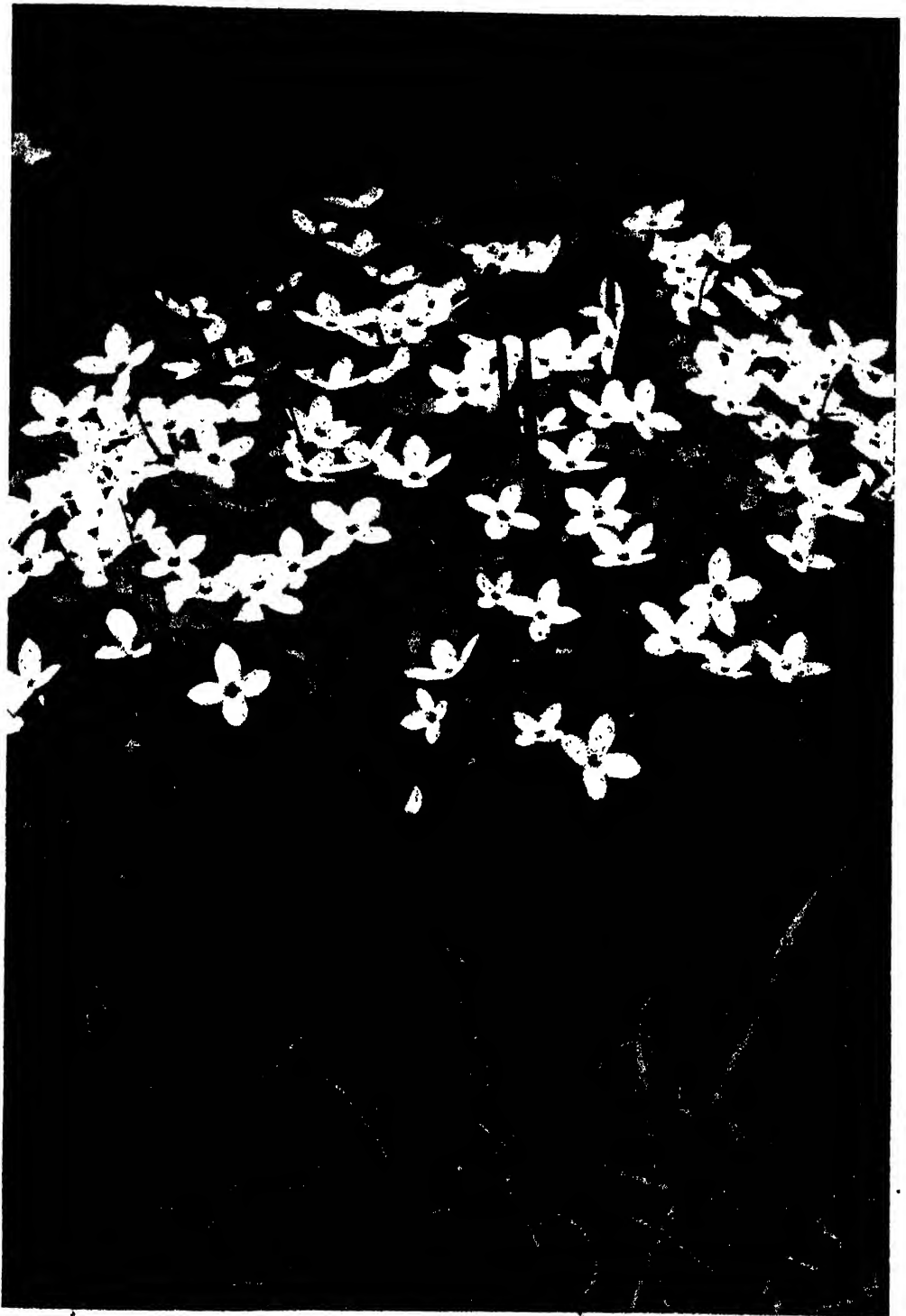
THE MADDER FAMILY

The flowers of the Madder Family (*Rubiaceae*) differ from those of all the plants so far considered, in that the petals are fused to form a tubular or funnel-shaped corolla with a lobed margin. Other families with this same characteristic will be described in later chapters. The Madder Family is one of the largest of all the flowering plants, there being five thousand species of wild flowers, shrubs and trees in the family. It is important economically, for in addition to coffee the family includes plants which produce substances useful as dyes and medicines. There are more representatives native to the United States than in either the Tea or the Cacao Families. In the southeastern states grow the Fever Tree and Wild Coffee; in our eastern and central states the shrubby Button Bush and various wild flowers including Bluets, Partridge Berry, Buttonweed, the Bedstraws, Goose Grass, Wild Liquorice and Madder. Species of economic importance are Coffee, Cinchona and Madder—the latter the source of the brilliant red dye alizarine.

Fever Tree (*Pinckneya*) is a small tree native to sandy swamps of the coastal plain, from South Carolina to Florida; it has broad elliptical leaves and five-lobed yellow or purple flowers which are made more conspicuous by their petaloid, pink bracts and sepals. Wild Coffee (*Psychotria*) is a shrub or tree of the Florida hammock and keys with oval leaves and white flowers, and red or orange berries for fruits.

Around the margin of swamps, ponds and streams one often finds a thicket of shrubby trees with small white flowers clustered in globular heads. This is Buttonbush (*Cephalanthus*), distributed from New England westward to Texas and New Mexico. The six species in the genus are all American and Asiatic in distribution. Buttonbush bark has been used for treating fevers, being rich in tannins.

The most attractive small wild flower of grassy meadows and open woods of the northeastern states is the Bluet (*Houstonia*—named after Dr. William Houston, an



Blucts (*Houstonia caerulea*) are small pale blue flowers which occur commonly in pastures and grassy fields. The Adirondacks, New York.

early English botanist). Bluets have a four-lobed pale blue corolla, and narrow grass-like leaves. Fourteen related species grow in the southeastern states, four or five ranging westward into the prairies; all are low-growing plants with small white, blue or pink flowers.

Partridge Berry (*Mitchella*—commemorating a Virginia doctor, John Mitchell, an early student of American plant life) is a creeping plant growing in damp mossy woods, throughout New England and westward to Texas and Minnesota. There are only two species in the genus, the other being native to Asia. Partridge Berry has round evergreen opposite leaves and small fragrant white berries. Buttonweed (*Diodia*) is another creeping plant, found in low ground and swamps from New England to Texas and Kansas. The small white or pink flowers are borne in the axils of narrow tapering leaves.

The Bedstraws (*Galium*) include over twenty species in the United States, most of them native to the South and East; they are low plants with four-angled stems, leaves in whorls and small white flowers in open clusters. Sweet-scented Bedstraw is a common plant with greenish white flowers found in the open woods from New England to Alabama and also on the Pacific coast. Goose Grass, a weak scrambling plant with whorls of six or eight leaves and white flowers, grows in dry rocky thickets from New England southward to North Carolina and west to Minnesota. Northern Bedstraw is another species, found in rocky woods in the north central states and frequently grown in rock gardens because of its compact clusters of white flowers. ⁴Wild Madder is a European species with bristle-tipped leaves grown in gardens for the mist-like effect of the profuse masses of small flowers.

The name *Cinchona* was given to a genus of South American trees because the Countess of Chinchon, wife of a Spanish official in Peru, was cured in the early seventeenth century by the use of the bark. The Cinchonas are shrubs and trees native to the Andes, with leathery evergreen leaves and fragrant white or pink flowers; from the bark of the roots, and sometimes from the trunk, quinine is secured. The medicinal value of the bark was known to the Indians before the coming of the Spaniards. Today little quinine comes from the Wild Peruvian trees, most of it being produced on plantations in India and Java. The value of quinine lies in its lethal effect upon the malaria micro-organism.

Coffee (*Coffea*) includes at least twenty species of shrubs and trees common to the Old World, many of them African. The coffee shrub which is the source of our beverage is native to Abyssinia; the name may be derived from the province of Kaffa in that country, where the coffee plant is known to grow wild. Coffee was in use in Abyssinia in the fifteenth century, but beyond that date its history is obscure. At the beginning of the seventeenth century the beverage was used in Egypt, Arabia and Turkey; especially during the religious ceremonies of the Mohammedans in order to keep the priests awake. Later, however, it was considered an intoxicating drink and prohibited by the Koran; but in spite of the prohibition it became the national drink of Arabia. About this same time the use of coffee spread to Europe, and coffee houses appeared in London about 1652. These played an important part in the social and literary life of the last two centuries, though coffee drinking in public houses was fought by many as a public moral evil and prohibitionists were active but unsuccessful. Until the end of the seventeenth century most of the coffee came from the Mocha

variety grown in Arabia. Then the Dutch began its cultivation in the East and West Indies; from the latter it spread to Brazil and Mexico. Today Brazil produces some two billion pounds annually—the greatest percentage of the world's supply. The United States consumes a great share of this, averaging eleven pounds per person annually in contrast to the British per capita average of somewhat less than a pound.

The Coffee shrub has bright green oval leaves and clusters of fragrant white flowers; the fruit is a dark red berry the size of a cherry, containing two seeds buried



RUBIACEAE

Coffee, Quinine (leaves), Buttonbush (upper right), Partridge Berry (lower right).

in a fleshy pulp. After the fruits are picked they are put through a machine where they are pulped and the seeds removed; in order to remove a parchment-like skin covering the seeds, they are allowed to ferment for a few days. The seeds are later dried and roasted, the latter an important process because it determines to a great extent the delicate aroma and flavor of the coffee. The flavor is due in part to the development of the aromatic oil caffeine during the roasting process; the physiological stimulation resulting from the coffee drinking is due to the presence of the drug caffeine, closely allied chemically to the theine of tea or the theobromine of cocoa. The best coffees come from Arabia, but most of the American grades are produced in Java or Brazil.

CHAPTER XXXII

The Myrtle Family and Its Relatives



A DIVERSE assemblage of wild flowers, economic plants, shrubs and trees are found in the families which are grouped in the Myrtle Order (*Myrtales*) ; many of these are aquatic or amphibious species common in swamps, ponds and coastal marshes. Most of the introduced and native plants of importance in the order are in the large Myrtle and Evening Primrose Families ; a few other species of interest are included in the Tupelo, Mangrove, Pomegranate, Loosestrife and Daphne Families.

THE MYRTLE FAMILY

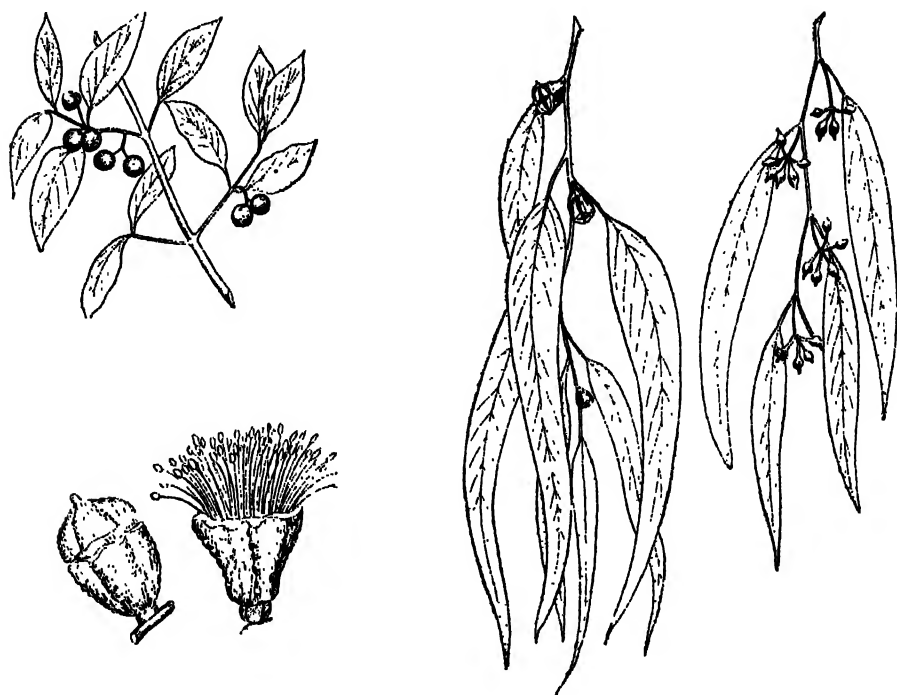
In the Myrtle Family (*Myrtaceae*) are many shrubs and trees with evergreen leaves and richly provided with aromatic volatile oils. The flowers, often very showy, consist of a four- or five-lobed calyx and usually a similar number of petals. The family is poorly represented except in Australia and the American tropics, where most of the three thousand species are found. The family is a source of valuable woods, gums, resins, oils and food products. The only native species are the Stoppers, Naked Wood and Spice Wood of Florida ; the ornamental Myrtle, Guava and Eucalyptus, or Australian Gum, are introduced plants ; and cloves, allspice and bay rum are procured from tropical members of the family.

The Stoppers (*Eugenia*) of the Florida hammocks and keys are a small advance guard of some eight species which have pushed northward from the tropics where five hundred of their relatives can be found. Spanish Stopper is a small shrubby tree with light brown checkered bark, tinged with red, and thick elliptical leaves ; the white flowers produce a black berry as fruit. Related species include the White Stopper with ashy gray branches and the Red Stopper with more pointed leaves and reddish tinged bark. Few of these grow more than thirty feet tall. The Clove Tree, another species of this genus, is found in the Molucca or Spice Islands of the Malay Archipelago. This is evergreen, growing to the size of an apple tree. The crimson flowers are not allowed to mature under cultivation, for the commercial cloves are the unopened flower buds. Each clove is a dried bud, the long cylindrical part being the ovary of the flower, surmounted by the four tooth-like lobes of the calyx, within which are the infolded petals. During the days of the Romans, traffic in cloves was very profitable since the price of this spice was several hundred dollars an ounce. Even in later times, various nations, as the Dutch and Portuguese, fought to control the profitable mon-

opoly in cloves. Most of the supply now comes from the West Indies and Mauritius Islands as well as from their original home in the Spice Islands.

Two other trees in the Myrtle Family, native to Florida, are the Naked Wood (*Ananomis*), a tree of the Florida Hammocks, with fragrant white flowers, often attaining a height of sixty feet; and Spice Wood (*Calypttranthes*), a more shrubby species with white flowers which have sepals but no petals.

Guava (*Psidium*), native to Mexico, Central America and South America, is a



MYRTACEAE

White Stopper (upper left), Eucalyptus flowers (lower left), *Eucalyptus rostrata* (right), *E. globulus* (center).

small tropical tree cultivated in Florida and to a lesser extent in California; in the former state it has escaped from cultivation and become naturalized in many areas. Guava trees grow to be twenty feet high, and have thick prominently veined leaves and white flowers each with four incurved petals and numerous white stamens. The spherical or pear-shaped fruit may have a diameter of four inches; a thin yellow skin covers the pulp which varies in color from white to deep pink. The flesh, sweet or slightly acid in taste, has a distinctive musky flavor; it is used in making beverages, cakes, pies and jellies. The making of guava jelly has become an important industry in several of the tropical American countries.

Allspice is made from the dried unripe berries of a tree (*Pimenta*) native to Jamaica, Mexico and Central America which has large leathery leaves and clusters of numerous small white flowers. Another species is the Bay Rum Tree, from whose

leaves the aromatic product is secured ; it is native to the West Indies and Venezuela.

True Myrtle (*Myrtus*) has no representative native to the United States ; the Periwinkles (*Vinca*) are sometimes called Myrtles, but they belong to another family. The Myrtle of the Greeks and Romans is a strongly scented shrub with glossy evergreen leaves and white or rose tinted flowers ; its fruits are like those of the blueberry. Myrtle, a native of the Mediterranean region, is cultivated in pots in our northern states, and out of doors in the South.

In the Myrtle Family we find the Australian Gum (*Eucalyptus*), one of the few trees that, in its native home, equals the Sequoias in stature—a genus which has made itself thoroughly at home over large areas in California which were previously treeless. Australian Gum is a large genus of Australian and Malayan trees, adapted to warm or semi-tropical climates. The leaves, narrow and tapering or sickle-shaped, hang in graceful pendant clusters. The trunk is covered with reddish-brown stringy bark which peels off in long shreds, uncovering the smooth light under-bark. Many trees are therefore generally white-barked and smooth. The flowers are unusual in that the corolla and calyx have fused to form a rather hard lid over the other floral parts. This lid falls off at maturity exposing the stamens which are the conspicuous structures—white, yellow or scarlet in color. The flower cup and lid are aromatically fragrant, as is also the foliage and bark ; from the tree comes eucalyptol and other medicinal oils. Australian Gums were introduced into California some forty years ago, and are now commonly seen throughout the southern and central parts of the state ; growing dense and tall they are used as windbreaks around citrus groves, as well as being street trees which arch overhead as do the Elms of New England. Over forty thousand acres of Gums were planted in the hope that they would serve as timber trees. They are rapid growers and soon become huge trees ; but the trunk is made up chiefly of sap wood, which checks readily in drying and is not strong enough for commercial use. Of the many introduced species, most common is the Blue Gum with narrow pointed leaves six to twelve inches in length and creamy-white flowers ; the rough calyx and lid are covered with a bluish white wax. Red Gum has smaller leaves and fruits, the latter with beaked or conical pointed caps. The Red-flowered Gum has showy masses of brilliant red blossoms, and is often grown as an ornamental small tree.

THE EVENING PRIMROSE FAMILY

The Evening Primrose Family (*Onagraceae*) includes some five hundred species of small flowering plants, chiefly American in their distribution. The calyx of the flower is usually of four sepals, sometimes fused at the base to form a tube-shaped structure ; the brightly colored corolla has four petals. The family is well represented among our native wild flowers, by the Evening Primroses, Sundrops, Enchanter's Nightshade, Fireweeds, Primrose Willows and False Loosestrife of rather wide distribution ; the Farewell-to-Spring, Red Ribbons, California Fuchsia and Baby's Breath of the western states ; and the garden Fuchsia.

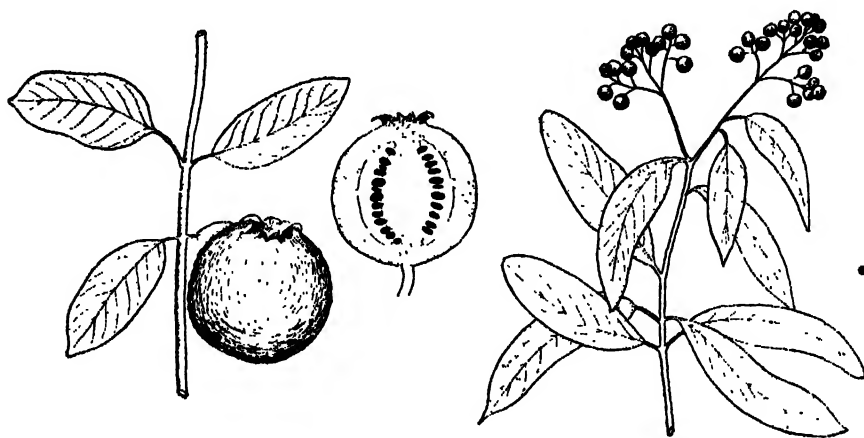
Evening Primroses (*Oenothera*) are stout plants with alternate or basal leaves and terminal or axillary spikes of flowers, each with reflexed calyx lobes and yellow or white petals ; in some species the flowers open only at night. It is a large genus with some ninety North American species, only a few of which we can consider here.



The Desert Primrose (*Oenothera deltoides*) is one of the many incongruously dainty flowers of the desert; its large pure white blossoms hide beneath the thorny desert bushes. Twenty Nine Palms, California.

species of the genus are found in our southeastern states. Seed-box is a native species found in wet places from New England to Texas and Kansas; the flowers, solitary in the leaf axils, have a four-parted calyx and four yellow petals. These are all plants of swamps; by contrast the Butterfly Weeds (*Gaura*) are inhabitants of dry and sandy soils, widely distributed throughout the United States. The white or pink flowers are in terminal clusters.

There are several genera in the Evening Primrose Family which are peculiarly western. Farewell-to-Spring (*Godetia*) is one of seventeen species growing on open hillsides of the Pacific coast states; it has showy lavender or purple flowers, each of four broad cupped petals. Other species, ranging throughout the far western states,



MYRTACEAE

Guava and Allspice plant.

have red, purple, cream or white flowers. Red Ribbons (*Clarkia*) is another showy flowered member of a genus whose six species are found from California to Washington, growing on dry sunny slopes and canyon sides. The sepals are bent backwards, and the four narrow purple or rose petals are deeply divided into three terminal lobes. Three of the petals point upwards and sidewise, the other one grows downwards. The scientific name commemorates Captain Clark of the Lewis and Clark Expedition. California Fuchsia (*Zauschneria*) is one of several Californian species found on dry slopes and in roadside fields. The funnel-shaped calyx is scarlet in color, the four small petals projecting slightly beyond the calyx and being less conspicuous. Several of the Fuchsia-like flowers are borne in a terminal leafy cluster. Baby's Breath (*Gayophytum*) is one of six species, some of which range eastward into the prairies; they prefer dry ridges and sandy slopes for their home and are common in the Pacific coast states. The plants are slender stemmed with narrow leaves and small white flowers in the axils of the upper leaves.

The familiar potted Fuchsia is a genus (*Fuchsia*) of some seventy species, mostly from tropical America; they are noted for their showy pendulous flowers which are brilliant shades of red and purple, sometimes streaked with white. The Fuchsia flower

has a long tubular calyx, usually scarlet colored, with four spreading lobes; and four smaller petals which vary in color from purple to scarlet and blue. Pistils and stamens project conspicuously beyond the petals. In their native countries, Fuchsias grow to be shrubs.

THE MANGROVE FAMILY

Saline and brackish habitats are shunned by the majority of flowering plants; but in the coastal marshes of the tropics there are some sixty members of the Mangrove Family (*Rhizophoraceae*) which show an interesting adaptation for living in



ONAGRACEAE

Evening Primrose, Sundrops, and Fireweed.

such locations. Mangroves (*Rhizophora*) are evergreen shrubs or small trees, growing to a maximum height of fifty feet, with oval leathery leaves and small nodding flowers of pale yellow. Young plants, since the base of their stem soon dies, send aerial roots—after the fashion of Banyans—downwards from the branches to form a characteristic mass of stilts which supports the shrubby tree. Propped up on these arching supports, the Mangrove is safely out of reach of high tides. One species is native to the United States, forming dense low “forests” over expanses of flat brackish marshes in southern Florida. Another interesting adaptation of the Mangrove is that the seed in the fruit often germinates while still attached to the parent; thus fruits can be found with projections several feet in length hanging downward from them, these being the elongating juvenile root system (hypocotyl). When the fruit does fall off it floats in a perpendicular position and is ready to germinate as soon as it reaches shallow water and the root tip strikes muddy bottom.

THE POMEGRANATE FAMILY

This is a small family (*Punicaceae*) of only two species of bushy trees native to the Mediterranean region and southern Asia, whose fruit is described in the most ancient

of Oriental literature. The crimson or yellowish flowers produce a fruit about the size of an orange, red in color with a leathery rind and numerous seeds. Introduced into Europe by the Carthaginians, it was given the name "malum punicum", or apple of Carthage; and from this the scientific name was derived. Pomegranates (*Punica*) have been grown for their fruit for thousands of years in Persia and India; they are also cultivated in Georgia, Alabama, Louisiana and Florida. In the latter state they have often escaped and become naturalized. In addition to producing edible fruit, the rind is used medicinally in making a compound useful in the expulsion of tapeworms, and the bark of the root furnishes an astringent.



ONAGRACEAE

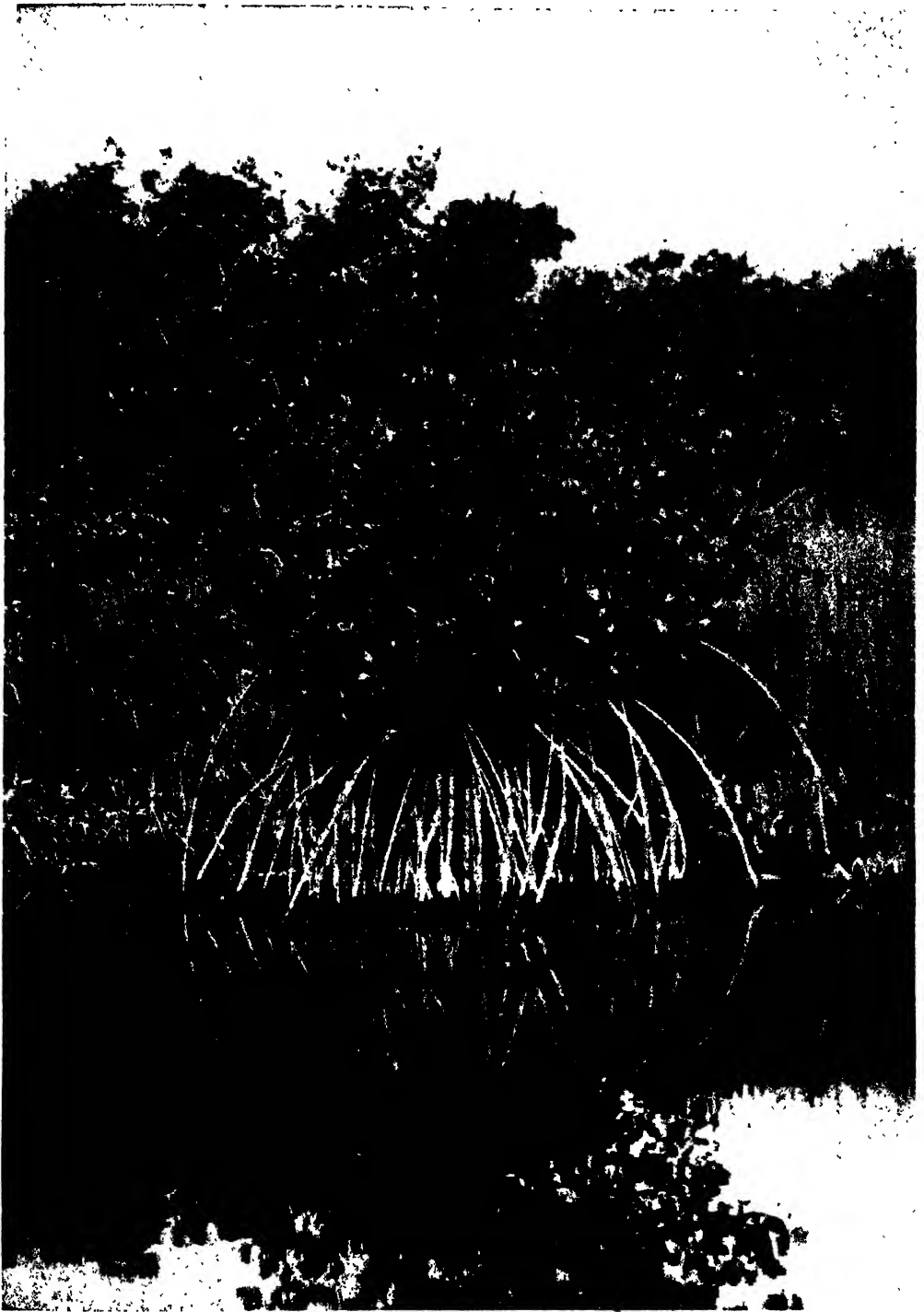
Farewell-to-Spring, California Fuchsia, ornamental Fuchsia.

THE TUPELO FAMILY

The Tupelo Family (*Nyssaceae*) is another family with but a few species; these are trees and shrubs of eastern North America and Asia, represented in the United States by four species of Tupelo (*Nyssa*). Tupelo, also known as Pepperidge or Sour Gum, is a tree sometimes one hundred and twenty-five feet in height, with oval entire leaves and clusters of small green flowers, each with a five-toothed calyx and five small petals; the fruits are dark blue elongated structures with a single large seed. Sour Gum grows in wet soil, often bordering swamps, from Maine south and west to Texas and Michigan. The wood is tough but not durable, and is used in making wheel hubs, yokes and soles of shoes. Another species, the Cotton Gum, a smaller tree with toothed leaves and dark purple fruits, is found from Virginia to Texas and Illinois, in swamps which are under water most of the year.

THE LEATHERWOOD FAMILY

The Leatherwood Family (*Thymelaeaceae*) includes about four hundred and fifty shrubs and trees of warm and temperate regions, but most of these are native to South Africa and Australia. Our only native representative is Leatherwood (*Dirca*), also



Mangrove shrubs (*Rhizophora Mangle*), propped up on their arching roots, are safely out of the way of high tides in the brackish swamps which they inhabit. Key Largo, Florida.

known as Moosewood; this is a deciduous shrub of damp woods from New England to Louisiana. The small lemon-yellow flowers, with four or five sepals and no petals, appear before the leaves. The name Leatherwood comes from the fact that the tough, strong bark was used by the Indians for making thongs and straps. The ornamental shrub *Daphne* (*Daphne*) includes about fifty species native to Europe and Asia, many of them common in American gardens. *Daphne* bushes have fragrant white or lilac-colored flowers and scarlet fruits; in some portions of New England they have escaped and become naturalized. In the southern states some of the species are evergreen.



PUNICACEAE, NYSSACEAE AND THYMELAEACEAE

Pomegranate; Tupelo; Leatherwood.

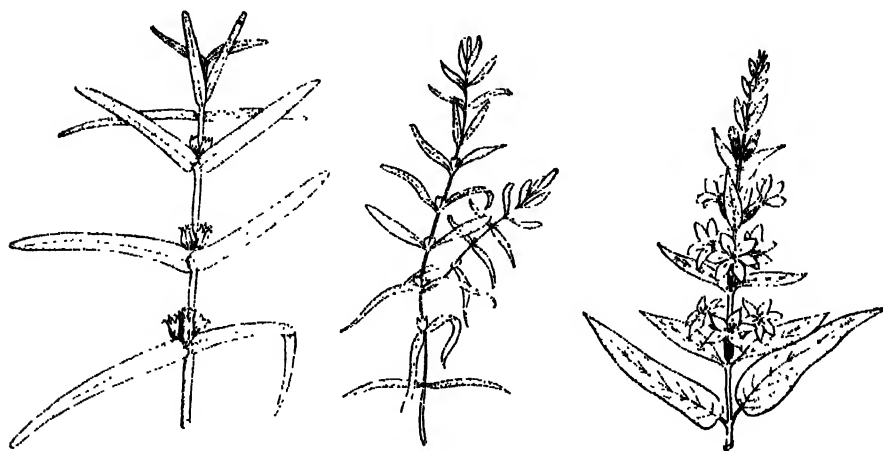
THE LOOSESTRIFE FAMILY

In the Loosestrife Family (*Lythraceae*) are included four hundred species of herbs and shrubs, most of which are found only in the American tropics. The plants have leaves which grow opposite each other, or whorled, and are frequently aquatic or amphibious in habit. The flowers have a tubular or funnel-shaped base, with a calyx made up of three to six segments and a like number of petals, sometimes none at all. The True Loosestrifes, Swamp Loosestrife, Wax Weed, Crape Myrtle, Tooth Cups and Water Purslane are our native representatives of the family.

The true Loosestrifes (*Lythrum*) generally have four-angled stems and purple flowers in the axils of the whorled leaves. A common White-flowered Loosestrife is found in brackish marshes of the southeastern states; its flowers, like those of the following two species, are generally produced singly along the stem. The Winged Loosestrife of swamps from New England to Louisiana and Minnesota has crimson or purple flowers. In the West the California Loosestrife, also with purple flowers, grows in marshy flatlands from California to Nevada and Arizona. Other species of True Loosestrife have larger flowers, usually crowded in a terminal spire-like mass. This is true also of the cultivated Spiked Loosestrife with its showy purple flower masses, often found as a garden escape in eastern United States.

Wax Weed or Tar Weed (*Parsonsia*) is a clammy-leaved plant growing in dry rocky soil such as is common in old fields; it ranges from New England to Louisiana and Iowa. The narrow pointed leaves are produced opposite each other or whorled, bearing rose-purple flowers in their axils.

Swamp Loosestrife, Water Willow or Water Oleander (*Decodon*) is an aquatic plant with opposite or whorled oval leaves and purple flowers in clusters in the leaf axils; it grows in swamps and ponds throughout eastern United States. Water Purslane (*Diplidis*) is a more submerged aquatic plant, rooting in the mud of ponds of the southeastern and central states; solitary greenish flowers, lacking petals, are



LYTHRACEAE

Tooth Cups, Water Purslane and Purple Loosestrife.

borne in the axils of the opposite narrow leaves. Tooth Cups (*Immannia*) is another swamp-dwelling member of the family, found from New Jersey to Texas and on the Pacific coast. Two to four purple flowers, each with four sepals and four petals, grow in the axils of the narrow opposite leaves; the calyx is prominently toothed between the projecting lobes.

Crape Myrtle (*Lagerstroemia*) is an Asiatic shrub and tree which has escaped from gardens and become naturalized in the southeastern states; it has a fluted trunk, and bears clusters of purple, pink or white flowers with attractively crisped petals.

The Carrot Family and Its Relatives



THREE related families of flowering plants are grouped into the Carrot Order (*Umbellales*), of which most of our native species are wild flowers or shrubby trees; the introduced species include a number of garden vegetables and herbs. All have small green or white flowers in clusters, and usually subdivided compound



ARALIACEAE

Wild Sarsaparilla, Dwarf Ginseng and Hercules' Club.

leaves. In the Ginseng Family the flower clusters tend to be spherical; in the Dogwood Family they are irregular or spherical, sometimes seated in showy white or pink bracts; and in the Carrot Family all the stems in each cluster spring from a common base, often resulting in a flat-topped type of inflorescence.

THE GINSENG FAMILY

Although the Ginseng Family (*Araliaceae*) includes five hundred species of herbs, shrubs and trees common to temperate and tropical regions, only a few are native to the United States. In most cases they have large compound leaves and compact clus-

ters of small white flowers with five often minute sepals and five or ten petals. Wild Sarsaparilla, Wild Spikenard, Ginseng and Hercules' Club are our only representatives of this family. English Ivy is an introduced species and the Rice Paper Plant is an Oriental genus of some economic importance.

Wild Sarsaparilla (*Aralia*) is a common plant of eastern woodlands, being found from New England to Georgia and Missouri; the short main stem bears a single long-stalked compound leaf, divided into three sets of oval pointed leaflets. Alongside the stem, and hidden by the leaf, is the flowering stalk terminated by three globular clusters of small white flowers. The fruit is a small blue-black berry. A close relative, Bristly Sarsaparilla or Wild Elder, with bristly stems and dark purple fruits, grows



ARALIACEAE AND UMBELLIFERAE

English Ivy ; Black Snakeroot.

in the open woods of New England, southward to North Carolina and west to Indiana.

Wild Spikenard, another species of *Aralia*, has similarly compound leaves but more numerous and larger clusters of greenish-white flowers and dark red or purple berries; it is prized in some sections of the United States for the spicily aromatic roots. Wild Spikenard grows in rich woods of our eastern and central states. California Spikenard is a far western relative, with clusters of similar flowers but with black berries; it is native to California and Oregon.

The only native tree in the family is Hercules' Club or Prickly Ash (*Aralia*) which grows along streams and on low ground from New Jersey to Florida and Texas. The prickly stems and branches bear pointed leathery leaves and large clusters of greenish-white flowers which in autumn become dark brown or purplish-black fruits. The bark of the roots and the berries have some medicinal value.

Dwarf Ginseng or Ground Nut (*Panax*, meaning in Greek a "cure-all") is a diminutive member of the family; its short erect stem terminates in a whorl of three small palmately compound leaves. From the midst of these rises the flowering stem with its solitary terminal cluster of small white flowers, each with five petals and minute sepals, which later turn into yellow fruits. Dwarf Ginseng is a common flower

of open woods in our eastern and central states. Ginseng, a related species with a whorl of three or four leaves which are usually divided into five lobes, and with scarlet instead of yellow fruits, is found in the cool woods of northeastern United States, southward in the mountains to Georgia. Although considered of minor medicinal importance in the United States, in China where other species are found, Ginseng is a highly prized drug plant. It is one of the few drugs exported from this country. The first Ginseng roots were exported to China from Canada in 1716; since then our native Ginseng plants have been greatly decreased in number due to continued uprooting for this purpose, until the plant is now well on its way to becoming a botanical rarity in the United States.

Rice Paper Plant (*Tetrapanax*) is an introduced ornamental, grown in warmer parts of the United States for its large palmately lobed leaves and luxuriant shrubby growth. In China, its native home, the soft pith of the tall stems is cut into lengths and made into the thin sheets known as rice paper.

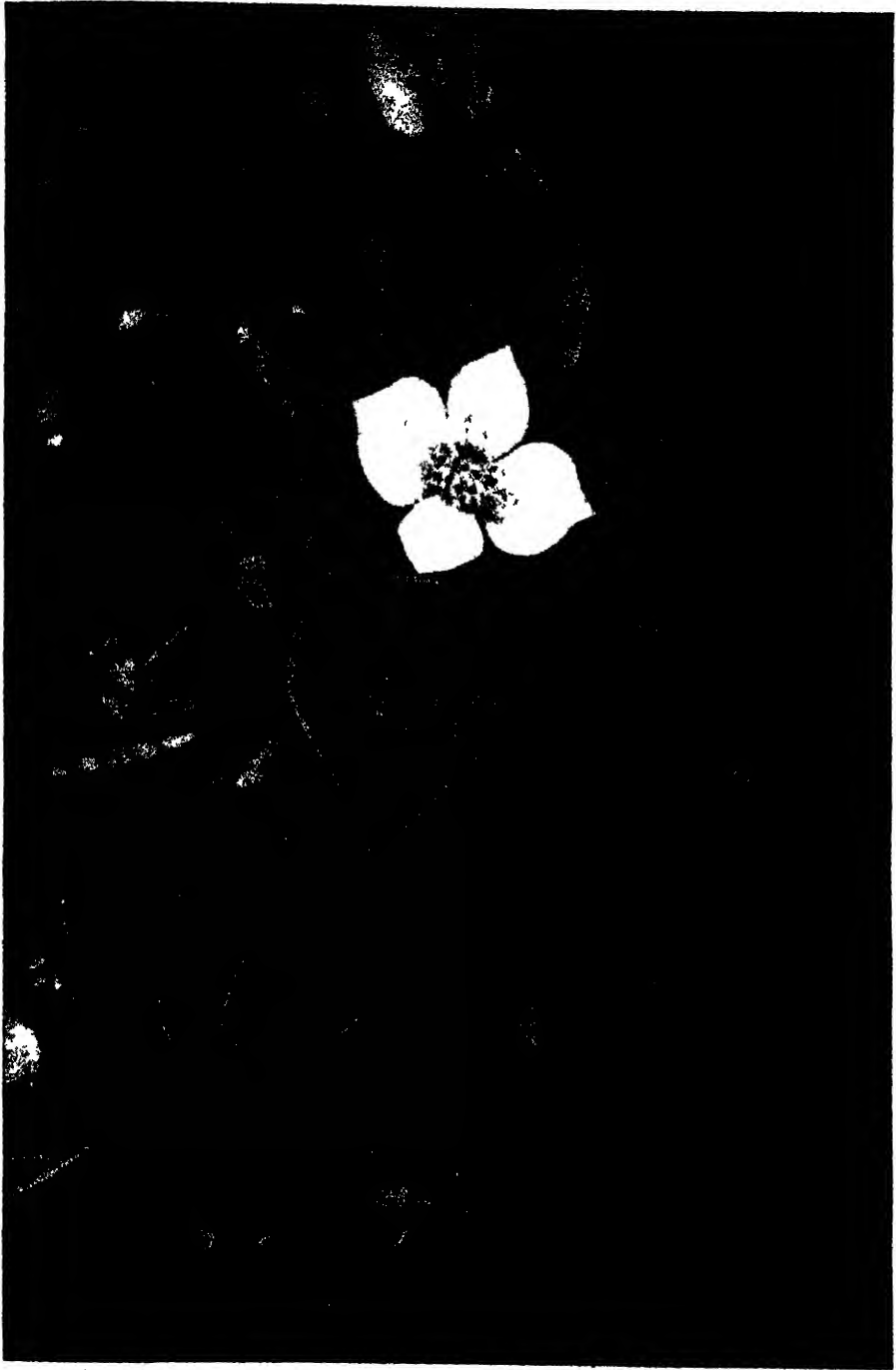
The common English Ivy (*Hedera*), which covers so many of our older American buildings with a venerable raiment of glossy green, is another ornamental member of the Ginseng Family. There are five species native to Europe, northern Africa and Asia. It is a vigorous woody climber, the stems provided with aerial roots which cling tenaciously to wood or stone surfaces. The leaves are three- to seven-lobed and the flowers, appearing in autumn, are borne in small greenish clusters; its fruits, the black berries, mature the following spring.

THE DOGWOOD FAMILY

The Dogwood Family (*Cornaceae*) includes less than a hundred species, mostly shrubs and small trees; all of our native representatives are various species of the one genus, *Cornus*. Other genera are found in Asia, South Africa and New Zealand. Dogwoods have clusters of small green, white, or yellow flowers, each of four sepals and four petals. In some species the showy petal-like bracts beneath each flower cluster, white or pink in color, are often mistaken for parts of the flower itself. The berry-like fruits are usually red, but blue, white and black varieties are also found.

One of the few herbaceous members of the genus is Dwarf Cornel or Bunchberry, a small but attractive plant of the colder portions of the United States from New England west to Washington and Oregon. The plant is rarely more than six inches in height, the short stem terminating in a whorl of oval and pointed leaves in the center of which is the cluster of small yellowish flowers usually surrounded by four large white bracts. In fall the flower cluster is replaced by bunches of bright red berries which lend color to large areas of ground in the open spots of our northern forests.

Flowering Dogwood is a small tree of the eastern states, abundant in the deciduous woods of southern New York southward to Texas and west to Minnesota. Dogwoods are graceful trees with alligator-checked bark and branches which curve upwards at their extremities. Beneath the compact clusters of greenish flowers are white or pink (usually four) petal-like bracts which make the Dogwood a showy tree in spring when it is in bloom; it is equally attractive in autumn when covered with bunches of bright red berries. The Flowering Dogwood of the western states, also known as Pacific Dogwood, grows in wooded mountain habitats in the Pacific coast states; it is a shrubby tree with showy white or pink bracts, red berries and typical Dogwood



Bunchberry (*Cornus canadensis*) has clusters of small yellowish flowers surrounded by large white bracts which resemble petals. South Brooksville, Maine

leaves—leaves with the lateral veins parallel to each other and converging at the apex. Several ornamental varieties are commonly used as lawn trees in the East, introduced from Europe and the Orient.

The other Dogwoods lack the petal-like bracts beneath the flower clusters. Such is the case with the purple-stemmed Creek Dogwood of California stream margins, a shrub with white flowers and white fruits; the Round-leaved Dogwood of rich or sandy soils from New England to Virginia, a tree with greenish bark and light blue fruits; the Silky Cornel or Kinnikinnik, common in woods from New England to Alabama and Minnesota, with silky hairs covering the undersurface of the leaves, purplish branches and blue fruit; the Red Osier Dogwood, a shrub with reddish stems and flattened flower clusters which in autumn become white or lead-colored berries, found in wet places from New England westward to Iowa.

The Alternate-leaved Dogwood is a shrubby tree differing from the other species of *Cornus* in having alternate instead of opposite leaves and greenish branches frequently streaked with white. The broad clusters of white flowers later change to bunches of blue berries. This representative of the genus is found in the woods of our eastern and central states.

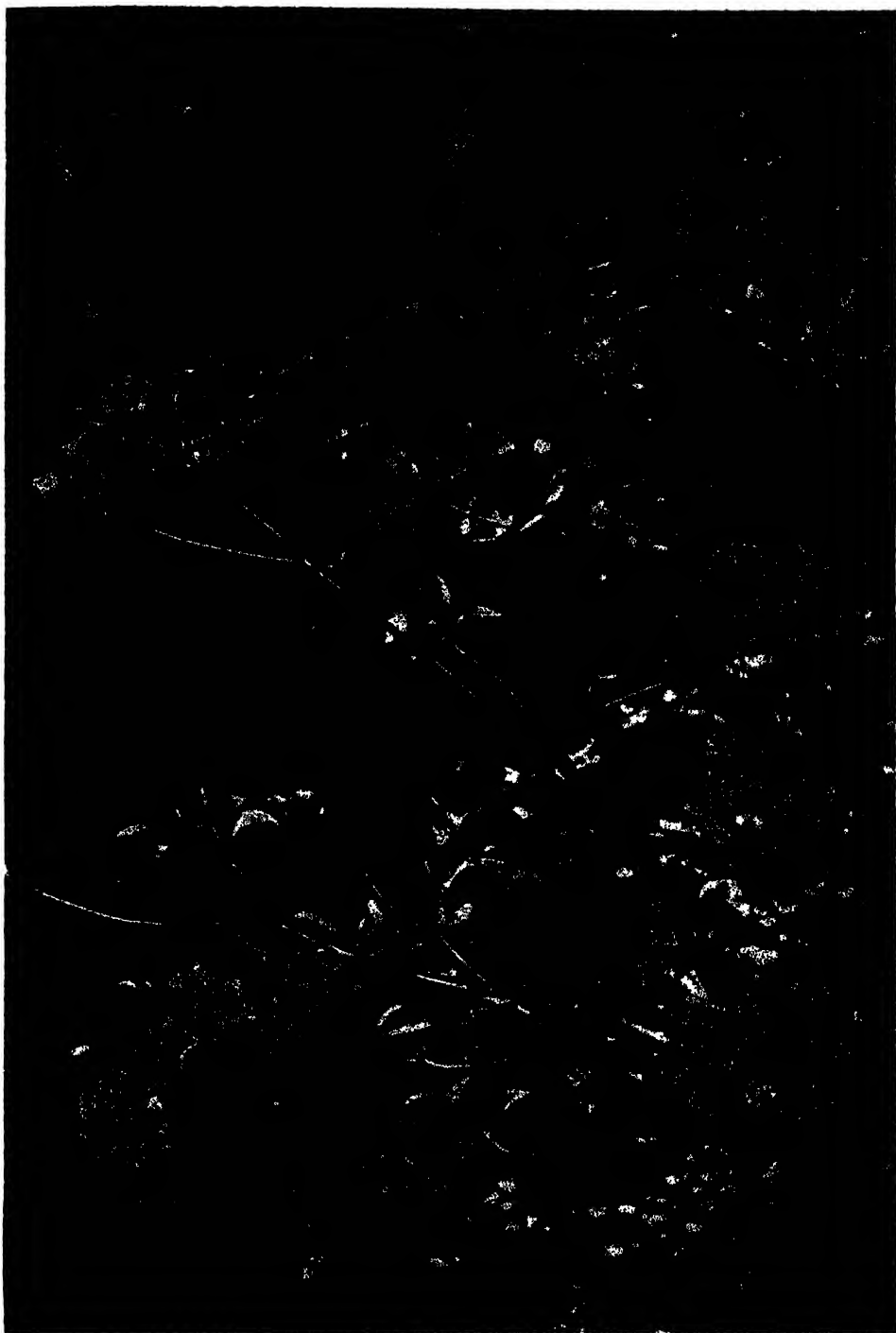
THE CARROT FAMILY

Members of the Carrot Family (*Umbelliferae*) are easily recognized by their characteristic type of flower cluster, known as an umbel, in which the stems of all the individual small flowers arise from the same place and thus present a flattened or slightly convex mass of flowers with gracefully arching stalks. The individual flowers are small, with five minute sepals which are sometimes reduced to small teeth, and five petals, usually bent inwards over the center of the flower. The fruits are small, dry, one-seeded structures united in pairs and often prominently ribbed or covered with spines. There are two thousand five hundred species, widely distributed, for the most part small herbaceous plants with hollow stems and compound leaves. There are many common wild flowers in the family—the Snakeroots, Pennyworts, Fennel, Parsnips, Angelica, Sweet Cicely, Chervil, Water and Poison Hemlocks; and many of the introduced garden species such as Carrots, Celery, Coriander, Caraway and Fennel have become naturalized as weeds in waste places.

Some of the members of the Carrot Family are characterized by fruits which are covered with scales, bristles or spines; such are the Button Snakeroots, the Black Snakeroots, Queen Anne's Lace and Carrot.

Button Snakeroot (*Eryngium*) has spiny, toothed and lobed leaves which are responsible for the common names of Button Thistles or Coyote Thistles given to the western species. They are plants of low ground and marshes, about a dozen species occurring in the southeastern states and a similar number on the Pacific Coast; only a few venture as far north as New England. The white or green flowers (sometimes blue) are clustered in heads, mixed with bracts which are sometimes also colored. The sepals are rigid and spine-like.

Black Snakeroot (*Sanicula*) is a smooth-stemmed plant with palmately compound leaves and clusters of white, yellow or purple flowers; the bracts beneath the flowers are usually green and leaf-like. There are a half dozen eastern and southern species, and about twice as many on the Pacific Coast where we find the common



Pacific Dogwood (*Cornus Nuttallii*) is a magnificent large-flowered member of the Dogwood Family, growing to the height of a small tree. Sequoia National Park, California.

purple flowered species known as Niggerhead and the poison Sanicle with yellow flowers.

The Carrot (*Daucus*) is a bristly stemmed plant with compound leaves and white or pink flowers in compact umbels. Rattlesnake Weed, a native species common to fields and waste places of our southern tier of states, grows from coast to coast; the small white flowers have petals of unequal size. The garden Carrot is a native of Europe and Asia which has been under cultivation in Europe for the last two thousand years. The sugary food is stored in the outermost layers of the enlarged tap root, the center of which is likely to become woody and pithy. This species has escaped



UMBELLIFERAE

Wild Carrot, Angelica and Wild Parsnip.

from cultivation and become a common wild flower and weed, known as Queen Anne's Lace.

The remaining members of the family do not have bristly or spiny fruits; the majority have white flowers, but there are a few yellow and purple flowered species. Of the white flowered forms we might mention the Water Pennywort, Harbinger-of-Spring, Sweet Cicely, Chervil, Water Hemlock, Water Parsnip, Cow Parsnip, and Caraway which are native plants; and the naturalized Shepherd's Needle, Coriander and Poison Hemlock.

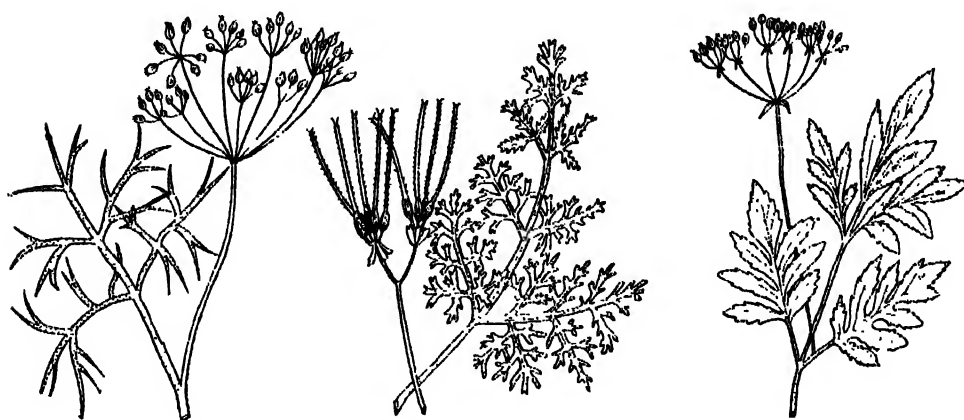
Water Pennywort (*Hydrocotyle*), common to swamps and wet meadows throughout the United States, has creeping stems which bear simple rounded or lobed leaves, thus differing from most of the members of the Carrot Family. The white flowers are grouped in small clusters springing from the leaf axils. In the southern states some species form extensive floating masses in quiet ponds.

Harbinger-of-Spring (*Eriogon*) is a plant of rich open woods found from western New York to Minnesota and southwards. It is a small plant with compound leaves divided into linear segments and a few white flowers in each cluster.

Sweet Cicely (*Osmorrhiza*) is a perennial herb, well known for its fleshy aromatic

root; the compound leaves have toothed leaflets and each umbel consists of relatively few white or purplish flowers. This species is recognized when fruiting by its elongated fruits which have bristles along the prominent ribs. There are fifteen American and Asiatic species; a common eastern variety grows in open woods of the northeastern and central states. Another species, known locally as Anise Root, has a more decidedly aromatic root. Two related species occur on the Pacific coast.

Chervil (*Chacrophylum*—literally meaning a “gladdening leaf” in reference to the pleasant odor of the foliage) is an annual herb of our eastern states, with narrowly segmented compound leaves and irregular umbels of white flowers.



UMBELLIFERAE

Fennel Shepherd's Needle and Parsley.

Water Hemlock or Spotted Cowbane (*Cicuta*) is a tall stout plant growing in wet ground from New England to North Carolina and Texas; its roots are very poisonous. The three-parted compound leaves and white flower clusters are large, and the fruits are characteristically marked with five corky ribs on their outer face. There are several western species, among them the Western Water Hemlock with purplish foliage, growing along mountain streams in the Pacific coast states. Water Parsnip (*Sium*) is another marsh or aquatic genus, growing to be a tall robust plant; it has pinnately compound leaves and white flowers in branching umbels. Water Parsnip is commonly found from coast to coast. Cow Parsnip (*Heracleum*) is another genus, also growing to be a tall stout plant of wet ground throughout the United States; the three leaflets of the compound leaf are each palmately lobed. The flowers are usually white, sometimes grading into a purplish tint.

Caraway (*Carum*) is represented by four native species in western United States, one of which is the Squaw Root found on California meadows and hillsides. The garden species is a native of Europe, with slender stem, pinnately compound leaves and white or pink flowers.

There are several white flowered European plants which have escaped from American gardens and become common wild flowers in various parts of the United States. Shepherd's Needle or Venus' Comb (*Scandix*) has finely lobed leaves like

those of the garden Parsley, and white flowers in numerous umbels; it is easily recognized when fruiting by the long needle-sharp beaks which project from each of the fruits. The slender-stemmed Coriander (*Coriandrum*) bears flowers with petals of unequal size, and globular fruits lacking the prominent ribs found in some of the other members of the family. The foliage is very strongly scented. Poison Hemlock (*Conium*) is a large herb with spotted stems and intricately compound leaves, its globular fruits marked with prominent ribs; the scientific name is the Greek word for Hemlock, the poisonous plant used in putting prisoners to death. The poison is of medicinal value.

The yellow or purple-flowered members of the Carrot Family include the Golden Parsnips, Meadow Parsnips, Angelica, and Fennel.

Golden Parsnip (*Zizia*) grows in thickets and grasslands of eastern United States, produces yellow flowers in branched umbels and bears large three-parted compound leaves. Meadow Parsnip (*Thaspium*) has similar leaves but purple flowers; it ranges from the Atlantic coast into the central states. Other species have yellow flowers.

Angelica (*Angelica*) is a stout perennial found in dry woods of eastern United States, with greenish-white flowers and flattened fruits characterized by a winged margin; one species grows on the Pacific coast. The roots and fruits of Angelica are used medicinally.

Hog Fennel (*Lomatium*), known as Whisk Broom Parsley in the central states, is a genus with twenty-one species native to the Pacific Coast region; they are plants with white, yellow or purple flowers, common to dry plains and hillsides. The majority have short stems, thick roots and finely divided compound leaves. European Fennel (*Foeniculum*) is a stouter and more aromatic plant with yellow flowers; it often escapes from gardens and has become naturalized in the eastern and far western states.

Garden plants of the Carrot Family in addition to those already mentioned include Parsnip, Parsley, Celery and Dill.

Parsnip (*Pastinaca*) is a native of the Mediterranean region, with pinnately compound leaves and yellow flowers; it has been cultivated in Europe since the time of the Romans. Parsnips are grown for their thick fleshy roots.

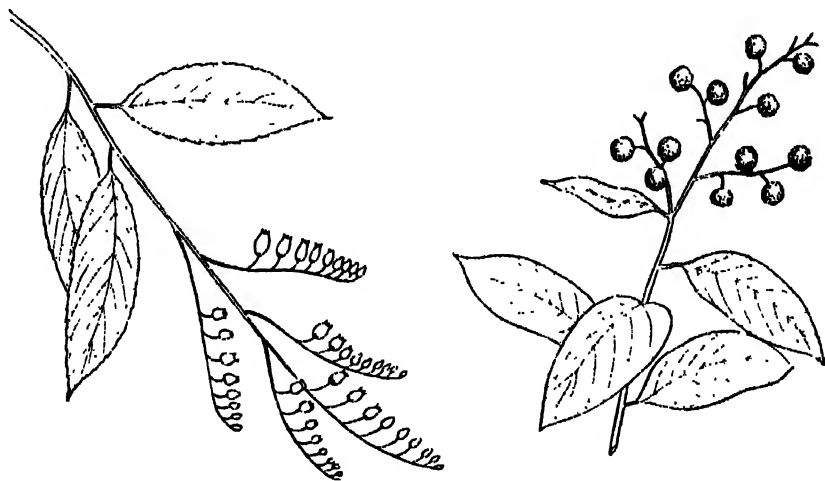
Parsley (*Apium*) is a small herbaceous plant with edible compound leaves and yellow flowers; there are five species, all European. The tender foliage has been used since classical times as a garnish. Celery is another species of the same genus, likewise a native of Europe, with compound leaves and small white flowers. Celery is grown for the fleshy leaf stalks, and has long been cultivated as food. Celery plants require cool weather and plenty of moisture for their best development; when grown in the warmer states they are a winter or early spring crop. In order to blanch the yellow stems, earth or boards are placed to keep the lower parts of the plant from sunlight which stimulates the development of chlorophyll. Celery has become naturalized in the marshes of California from the Sacramento valley southward.

Dill (*Anethum*) is a native of southern Europe, and is grown for the bitter flavored seeds which are used for seasoning, as are those of Caraway and Coriander. It is a hardy plant with the compound leaves and clusters of small yellow flowers found in so many members of this family.

The Heath Family and Its Relatives



THE typical flower of the various families considered in previous chapters consisted of separate sepals and petals, a condition considered primitive among Angiosperms; such were the flowers of the Buttercups, Poppies, Roses and Mallows. As the evolution of flowering plants took place there was a tendency toward specialization for



ERICACEAE

Sorrel Tree and Madroño.

insect pollination which resulted in a fusion of the sepals or petals, or both, to form a tubular flower. This sympetalous condition, as it is called, reaches its climax in the Composites; it is also characteristic of many other families such as the Honeysuckle, Figwort, Nightshade, Mint, Verbena, and Morning Glory Families—which will be considered in following chapters. Intermediate between these and the families with separate sepals and petals is the Heath Order (*Ericales*) which shows both characteristics; this includes the Heath, Wintergreen and Huckleberry Families. The colorless Indian Pipe Family will be considered in the chapter on parasitic and saprophytic plants.

THE HEATH FAMILY

In the Heath Family (*Ericaceae*) we find a large group of fourteen hundred species of plants which are most abundant in temperate regions, many of them partial to the cool woods and bogs of our northern tier of states. The majority are trees or shrubs, evergreen and deciduous; only a few are low-growing species. The four to seven petals may be free or united to form an urn-shaped corolla; the sepals are free from the ovary of the flower, this latter characteristic differentiating the Heath Family



ERICACEAE

Mountain Laurel (*left*), Great Laurel or Rhododendron (*right*)

from the Huckleberry Family. There are two native trees in the family, Sorrel Tree and Madroño. The Shrubby species, some of which grow to be small trees, include Azalea, Rhododendron, Laurel, Minnie Bush, Rusty Leaf, Stagger Bush, Fetter Bush, Red Heather, Sand Myrtle, Labrador Tea, Leatherleaf, Wild Rosemary and Manzanita. Smaller, prostrate plants are Checkerberry, Trailing Arbutus and Bearberry.

Sour Wood or Sorrel Tree (*Oxydendron*) is so named because of the acid-tasting foliage; the scientific name means literally "sour tree". This deciduous tree is found from Georgia to Alabama, sometimes reaching a height of sixty feet. The elliptical leaves are toothed, and the small white flowers droop in one-sided clusters.

Madroño (*Arbutus*), commonly found on hillsides and in canyons from Cali-



Western Azalea (*Azalea occidentale*) in full bloom. Yosemite National Park, California.

fornia to Washington, is a shrubby tree with leathery evergreen leaves and satiny reddish-brown bark; the white globose flowers are borne in dense terminal clusters, as are the orange-red fruits.

The best known shrubby members of the Heath Family are the Azaleas and Rhododendrons; the former usually deciduous plants with a long funnel-shaped corolla of partly united petals, and the latter evergreen shrubs or trees with a short-tubed corolla. Both are found in Asia as well as in America; our native species occur most abundantly in the southeastern states.

Pink Azalea or Wild Honeysuckle (*Azalea*), a densely branching shrub, grows to a height of eight feet; it has narrow pointed leaves and fragrant pink or white flowers with projecting pink stamens. This plant inhabits woods and low ground from New



ERICACEAE

Labrador Tea, Wild Rosemary and Leatherleaf.

England south to North Carolina and Tennessee. Swamp or White Azalea is a slightly smaller shrub of swamps from New England to Florida and Ohio. The yellow, scarlet or orange flowered Flame Azalea, one of the most showy species, grows in open woods from New Jersey to Alabama and Tennessee. Western Azalea, found on moist hills of California, has white flowers which are sometimes spotted with yellow. Many of the brilliantly flowered garden varieties of *Azalea* are Chinese or Japanese species, or hybrids of these with our native forms. The beautiful but rare *Rhodora* of our northeastern states is a species of damp mountainsides; the rose-purple flowers have a short corolla tube, and a three-lobed posterior portion with recurved anterior petals.

Of the hundred species of *Rhododendron* (the ancient name for the genus, meaning Rose Tree), the majority are found in Asia. The most magnificent of our native flowering shrubs—sometimes growing to be a small tree—is the Great Laurel or Rose Bay, with thick dark green leaves which droop and curl up in winter. The large pink or white flowers, each broadly bell-shaped, grow in showy compact clusters. Great Laurel is most abundant throughout the Allegheny Mountains. Mountain Rose Bay or Purple Laurel, a smaller shrub with more rounded leaves and lilac or rose-purple flowers, is found on bluffs and mountain slopes from West Virginia to Ala-



Swamp Laurel (*Kalmia polifolia*) is a shrubby member of the Heath Family. Hamilton, New York.

bama. There are several other species native to our southeastern states, where gardens of native Rhododendrons and Azaleas are often the cause of great civic pride. On the Pacific coast the California Rose Bay, with rose-purple flowers, grows to a height of eight feet ; it is found in the Redwood forests of California and Oregon.

The Laurels (*Kalmia*—named after Peter Kalm, pupil of Linnæus who visited the United States and studied its plant life) are also evergreen shrubs. They have a leathery five-parted calyx and the five-lobed corolla is wheel-shaped with pouches into which fit the tips of the stamens. Mountain Laurel or Calico Bush grows



ERICACEAE

Trailing Arbutus, Bearberry and Heather.

to be a stiffly branching shrub of fifteen feet, often forming impenetrable thickets in rocky and sandy woods from New England to Louisiana ; it has pointed leaves and showy pink or white flower clusters. Sheep Laurel or Lambkill is a much smaller shrub (rarely more than two feet high) with leaves which are opposite or in threes, paler green on the undersurface, and with smaller deep pink flowers. This species is common on hillsides and in pastures, as well as in bogs, from New England to Georgia. Pale or Swamp Laurel is a shrub of about the same size, with pink or purple flowers, usually found in bogs from New England to the Pacific coast.

A dwarf, low evergreen shrub of the Heath Family is the Sand Myrtle (*Leiophyllum*) of sandy pine barrens from New Jersey to the Carolinas. The terminal flower clusters are made up of white or pink flowers with spreading petals. Of the same general aspect and foliage is Labrador Tea (*Ledum*), another low evergreen shrub ; its leaves are characteristically rusty woolly on the undersurface and the small white flowers have five spreading petals. It prefers bogs and wet mountain slopes in our northeastern states. The foliage of Labrador Tea is fragrantly aromatic when bruised. West of the Rocky Mountains is found a related species with similar flowers and fragrant leaves.

Minnie Bush (*Menziesia*), a deciduous shrub with a straggling habit of growth and leaves with chaffy bristles, has greenish or purplish white urn-shaped flowers each



Manzanita (*Arctostaphylos glauca*) is a western shrub with satiny smooth red trunk and evergreen gray-green leaves. San Jacinto Mountains, California.

with a four-lobed corolla ; it is found in the Allegheny Mountains from Pennsylvania to Georgia. Another species known as Rusty Leaf is a taller shrub of the Pacific coast, with rusty hairs on the uppersurface of the leaves and similar greenish purple flowers.

Two bog plants of our northern states are Leatherleaf and Wild Rosemary. Leatherleaf (*Chamaedaphne*), a low-growing shrub with narrow evergreen leaves, bears its drooping white urn-shaped flowers all on one side of the tip of the stems, in the axils of the leaves. This bog plant is found from New England to Georgia, westward to Alaska. Wild Rosemary (*Andromeda*) is a smaller shrub of peat bogs from



PYROLACEAE

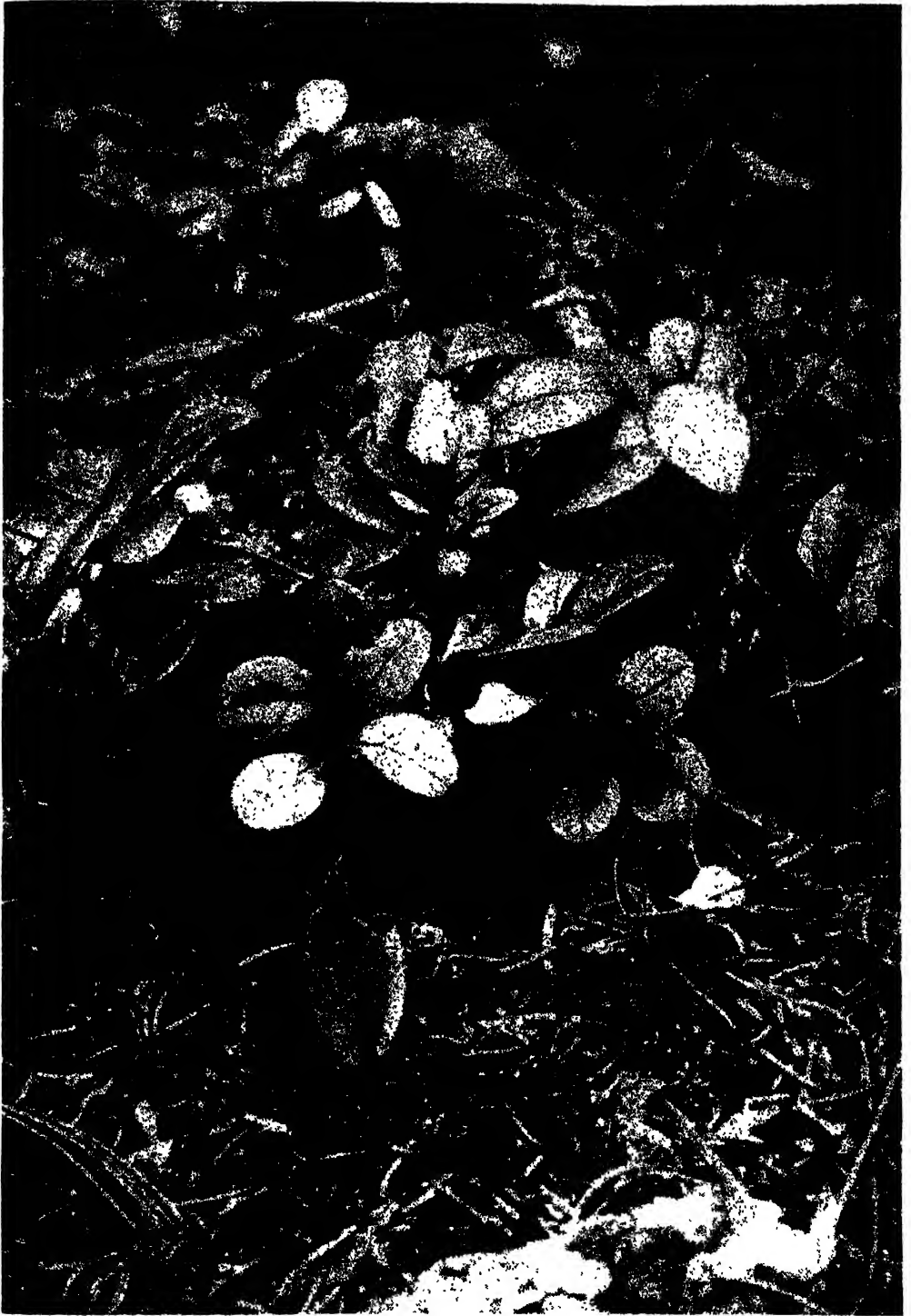
Shinleaf, Pipsissewa and Single-flowered Wintergreen.

New England to Pennsylvania and Michigan ; its white drooping flowers, each with five small recurved teeth, are borne in small clusters.

Stagger Bush (*Necopieris*), a deciduous shrub found in pinelands and on prairies from New England to Arkansas, is conspicuous because of its habit of producing flower clusters on the leafless branches of the preceding season's growth. Each nodding flower has a white or pink cylindrical corolla.

Numerous genera of the Heath Family are known as Fetter Bushes. A deciduous Fetter Bush (*Eubotrys*) with white flowers in terminal clusters is one of three species found in our southeastern bogs. Mountain Fetter Bush (*Pieris*), an evergreen shrub with white flowers in axillary and terminal clusters, is found in the mountainous region from Virginia to Alabama.

Red Heather (*Phyllodoce*) is a dwarf evergreen shrub of the California moun-



Checkerberry (*Gaultheria procumbens*) is the source of the wintergreen oil used for flavoring. Adirondack Mountains, New York.

tains, with dense terminal clusters of rose colored flowers, each with a spreading five-lobed corolla.

Bearberry (*Arctostaphylos*), a trailing evergreen, grows on rocky hills in our northeastern states. The white flowers are in terminal clusters, each corolla with five short recurved teeth; the red berries are inedible. On the Pacific coast the genus is abundantly represented by twenty-five species of shrubs and trees known as Manzanita, whose smooth red-barked branches and trunks are similar to those of the Madroño. The evergreen leaves are elliptical or oblong, and gray-green in color; often they are vertically placed on the branches. The white or pink urn-shaped flowers occur in dense clusters, as do the brownish red berries.



VACCINIACEAE

Cranberry, Tangleberry and Snowberry.

The wintergreen oil used in flavoring is distilled in the southern Appalachian region from the creeping aromatic Checkerberry or Teaberry (*Gaultheria*), sometimes known as Creeping Wintergreen. It is found in woods, often under evergreen trees, from New England to Georgia and Michigan. The dark green leaves are oval and shiny; and in their axils grow the solitary white or pink flowers. The globular red berry is mealy and spicy in flavor. A western species known as Salal grows to be a slender shrub with evergreen leaves and white or pink flowers, in the Redwood forests from California northward.

One of the most prized plants of the northeastern states is the Trailing Arbutus or Mayflower (*Epigaea*), a creeping plant covered with rusty hairs and producing oval evergreen leaves and clusters of attractive and fragrant pink (sometimes white) flowers, each with a broad five-lobed corolla. Trailing Arbutus grows in dry woods from New England to Mississippi. This most attractive of our northeastern flowers is fast becoming extinct since it is almost impossible to pick the flowers without uprooting some of the plant itself; it is also very sensitive to environmental changes brought about by lumbering, grazing or other human activities.

The common Heather (*Calluna*) of Europe and Asia Minor is often cultivated as a border shrub because of the profusion of its small rosy pink flowers in long plume-like



Shinleaf (*Pyrola elliptica*) sends aloft a long stemmed flowering stalk bearing waxy-white nodding blossoms Sargentville, Maine

clusters. It is an evergreen shrub with scale-like leaves arranged opposite each other in four rows. Unlike the true Heaths, the corolla is shorter than the four-parted colored calyx. The true Heaths (*Erica*) with five hundred species constitute a large genus best represented in southern Africa and the Mediterranean region; the small leaves usually grow in whorls of three to six. The bell-shaped or tubular flowers have white, rose or yellow corollas. Heaths are more successfully grown in Europe than in this country, for relatively few species can survive the extreme heat of our summer months.

THE WINTERGREEN FAMILY

The Wintergreen Family (*Pyrolaceae*) includes some twenty-five or thirty species of herbaceous plants native to colder temperate regions; in the United States they are found mostly in the cold woods of our northern states, from coast to coast. The flowers consist of four or five separate waxy petals and a similar number of sepals. In the Wintergreens or Shin Leaf there is no leafy stem, the few large leaves forming a basal cluster. Pipsissewa or Prince's Pines have a short leafy stem.

The Single-flowered Wintergreen (*Moneses*) differs from other members of the family by having a single terminal flower—usually white or rose colored; the basal leaves are thin and veiny. This is a genus found in cold woods from northern New England and New York west to the northern Pacific coast states.

The Wintergreens (*Pyrola*) have subterranean rootstocks terminated by a cluster of leaves from the center of which the flowering stalk arises, bearing white nodding flowers. Shin Leaf, a common representative of the genus in dry woods from New England to Virginia and Iowa, has dull, elliptical leaves and white or pink flowers. Round-leaved Wintergreen, ranging over the same area, has shining and rounded leaves and prefers open sandy woods. Among other species found in the northern states in cold mossy and swampy woods are the Bog Wintergreen and the Liver-leaf Wintergreen, both with purplish-pink flowers and both found from New England to the Pacific coast; and the One-sided Wintergreen, likewise ranging from coast to coast in rich woods, whose greenish-white flowers are all turned to one side. A Western Shin Leaf growing in pine woods from the Pacific coast to the Rocky Mountains has greenish-white flowers and leaves mottled with white.

Pipsissewa or Prince's Pine (*Chimaphila*) is a closely related genus with a more leafy stem; the narrowly-wedge-shaped leaves are shining and bright green; the flowers, in terminal clusters, are white or pink with a darker pink base. Pipsissewa is common in dry woods—usually under pines—from New England to Georgia and Wisconsin. A western variety of this species is found from the Rocky Mountains to the Pacific coast. Spotted Wintergreen has leaves variegated with white spots and a few white flowers in a terminal cluster; its range is practically the same as the Pipsissewa. The Western Pipsissewa, of shaded woods from California to Washington, has one to three white flowers in a small terminal cluster.

THE HUCKLEBERRY FAMILY

In the Huckleberry Family (*Vacciniaceae*) are some three hundred, mostly shrubby, plants some of which are evergreen, others deciduous; the distinctive character of the family is the bell-shaped or urn-like corolla with the tube of the calyx adhering to the



Blueberry (*Vaccinium pennsylvanicum*) blossoms are pinkish-white nodding bells, as beautiful as the juicy berries are tasty. Barneveldt, New York.

ovary so that when the edible berry is formed it is crowned by recurved calyx teeth.

The Huckleberries (*Gaylussacia*, named after the distinguished French chemist Gay Lussac), are shrubs with white, pink or red flowers; the fruit is berry-like with numerous little seed-like nuts buried in the fleshy pulp. Box Huckleberry of West Virginia and adjacent states has dark blue fruit; it is the only evergreen Huckleberry. Tangleberry is another eastern species, ranging from Louisiana to Ohio, with white flowers and bright blue fruits. The common Black Huckleberry, a shrub of rocky woods and thickets from New England to Louisiana, has pink or reddish flowers and sweet blue-black fruits. Several other species are native to the eastern and southern states.

Blueberries (*Vaccinium*) are shrubs with cylindrical or globular flowers, white or pink in color. Sparkleberry sometimes grows to be a small tree, found in the woods from Virginia to Texas; it has white or pink flowers in leafy clusters, later becoming shiny black berries. Deerberry or Squaw Huckleberry has a green or yellow berry with a tart flavor; it grows on open hillsides from New England to Louisiana and Minnesota. The Evergreen Blueberry has evergreen leaves and blue-black berries; it grows on sandy barrens from Virginia to Louisiana. The common eastern Blueberry is a dwarf shrub with shiny leaves, bright green on both surfaces, and blue-black berries often covered with a bloom. A dozen or more other species, some tall and some dwarf, are found in the eastern states. There are two western species. The Western Blueberry is a low shrub with blue-black berries, thriving in swampy habitats from California to Washington. Red Billberry, a tall shrub with red berries, is found in the Redwood forests of the Pacific coast. Blueberries are rarely cultivated, the market supply coming from wild plants. Most of the canned blueberries come from the coastal region of Maine, where Blueberry bushes form extensive pure stands on the shallow soil cover over the granite bed rock.

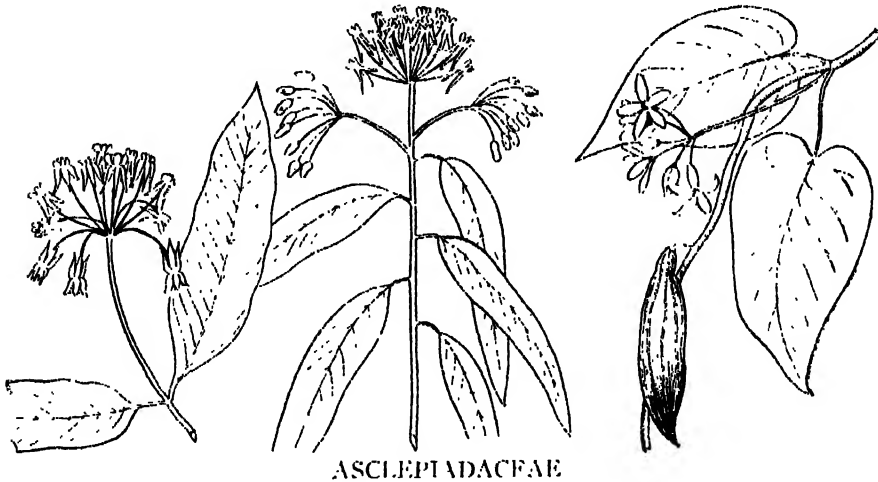
Creeping Snowberry or Moxie Plum (*Chiogenes*) is a trailing aromatic evergreen with slender woody stems and rust colored bristles on the branches and the lower surface of the leaves. The small greenish-white flowers are solitary and drooping, giving rise to white berries. Creeping Snowberry is a plant of wet woods and bogs from New England to North Carolina and Minnesota.

The name Cranberry is supposed to be a modification of Crane-berry, since the flower, just before it opens, resembles the beak and head of a crane. Cranberry (*Oxycoccus*) is a trailing plant with evergreen leaves and small pink four-lobed flowers, native to bogs from New England to New Jersey and west to Wisconsin. The fruit is the familiar red acid berry, so essential a part of the traditional Thanksgiving dinner. Until the middle of the last century the market supply came from wild plants, much as Blueberries do now. But since then cranberry culture has resulted in growing the plants in bogs and cultivating them like any other crop. Most of the cranberries come from Massachusetts, New Jersey and Wisconsin.

Milkweeds, Gentians and Their Relatives



A NUMBER of families of sympetalous plants are grouped in the order *Contortae*, which includes many common wild flowers, some cultivated shrubs, a few trees and several species of economic importance. These are the Milkweed, Dogbane, Gentian, Olive and Logania Families.



ASCLEPIADACEAE

Common Milkweed, Butterfly Weed and Western Anglepod.

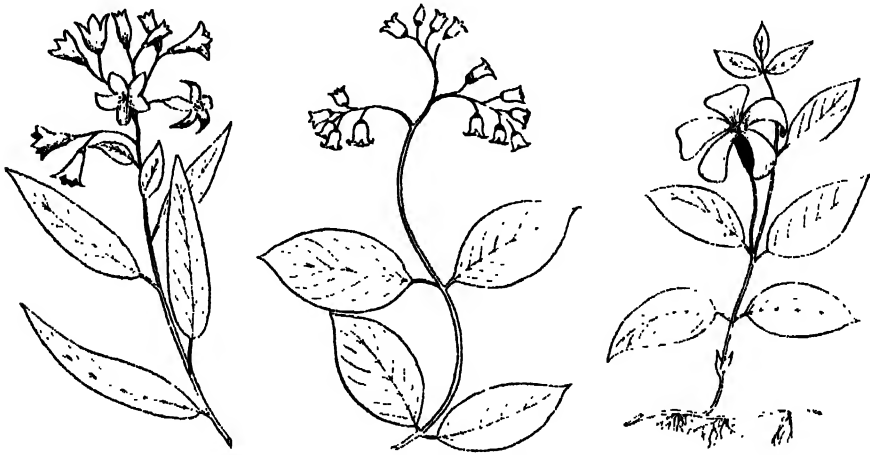
THE MILKWEED FAMILY

The Milkweed Family (*Asclepiadaceae*) is a large assemblage of two thousand species of herbs, vines and shrubs with a milky juice. Though widely distributed from cold temperate regions to the tropics, they are most abundant in Africa where they occupy arid regions similar to the habitats of our American succulents. The leaves are usually opposite or whorled and the flowers, with a deeply five-lobed calyx and corolla, are borne in umbels. Practically all our native members of the family belong to the Milkweed genus, with the exception of a few vine-like species.

On our southwestern deserts grows the yellow flowered vine *Astephanus*, with the flower umbels in the axils of narrow linear leaves. Another genus, *Fernastrum*, with

greenish-purple or yellow flowers, also grows in the same arid region. The Eastern Anglepods (*Vincetoxicum*) have a wheel-shaped corolla with a small crown in its throat; they are stout vines with large heart-shaped leaves and greenish-purple flowers. Most of the eastern species are vines growing along river banks in the southeastern states, ranging westward into Texas. A closely related Western Anglepod grows on the California deserts. The pods are armed with projections, ribs, or spines which vary in the different species.

The pointed pods of the Milkweeds, filled with silky-haired seeds, are familiar sights along the eastern roadsides, especially noticeable when the pods break open



APOCYNACEAE

Texas Star, Spreading Dogbane and Periwinkle.

and the delicate buoyant seeds float through the air, borne by the slightest current. Milkweeds or Silkweeds (*Islepius*) are tall plants whose flowers are peculiar in that they have a third floral part inside of the petals; the calyx lobes are small and bent backwards, as are the five segments of the corolla, on the inside of which is the added flower part in the form of a crown of five hooded projections, each with an incurved horn. There are ninety-five species, mostly American. Of those found in the western states, the Narrow-leaved Milkweed is a greenish flowered species found in dry places from California to Oregon and Arizona; the Desert Milkweed, a woolly stemmed plant of the southwestern deserts, has greenish flowers with yellow hoods. There are many eastern species growing in a variety of habitats. The Common Milkweed is a stout plant with large elliptical leaves arranged opposite each other, and large clusters of purplish flowers; it grows everywhere along roadsides and in fields in the eastern and central states. Butterfly Weed or Pleurisy Root has a stout hairy stem, alternate oblong leaves, and bright orange flowers whose corolla segments are bent backwards; it inhabits dry fields throughout the same range as the Common Milkweed. Swamp Milkweed has red or rose-purple flowers and slender smooth stems with opposite pointed leaves; it grows in marshy places from the Atlantic coast west to Colorado. The Blunt-leaved Milkweed is a plant of dry sandy soil of all the

eastern states, west to Texas and Minnesota; the opposite leaves have a distinctive wavy margin and the flowers are a nondescript greenish purple. The flowers of the Four-leaved Milkweed, on the other hand, are pink or white, borne in clusters above the opposite or whorled leaves which are broadly heart-shaped in outline.

The Carrion Flowers (*Stapelia*) are unusual cactus-like plants with succulent four-angled leafless stems which are usually mottled or covered with tubercles; the flowers are often foul-smelling, with a purple or brown mottled corolla, five-parted as is the calyx. About sixty species are native to southern Africa; one has flowers twelve inches in diameter. *Stapelias* are frequently cultivated in succulent collections.



GENTIANACEAE

Marsh Pink, Fringed Gentian and Bottle Gentian.

THE DOGBANE FAMILY

There are about a thousand (chiefly tropical) shrubs, herbs and vines in the Dogbane Family (*Apocynaceae*), provided with a milky juice and small five-parted flowers. Our only native members of the family are the Dogbanes; Periwinkle is a naturalized species, and Oleanders are introduced ornamental shrubs.

The only native species with alternate leaves are the Texas Star (*Amsonia*) and the Blue Dogbane, another species of the same genus. Texas Star, dwelling in moist woods and on river banks in our southern and central states, has purplish-blue flowers bearing spreading or reflexed corolla lobes. The western Blue Dogbane grows on dry slopes of the southwestern deserts.

Dogbane and Indian Hemp (*Apocynum*) are perennials with upright branching stems and opposite dark green oval leaves; the fruit consists of pairs of long slender capsules. Spreading Dogbane has drooping leaves, a forked method of branching, and clusters of nodding pink flowers, each bell shaped with recurved lobes; it is common along roadsides and in dry open woods from New England to California. Indian Hemp has pale green erect leaves and clusters of tubular greenish-white flowers; it has a transcontinental range, growing on gravelly or sandy stream margins and beaches.

Climbing Dogbane (*Trachelospermum*) found in damp habitats from Delaware to Texas is a climbing species with clusters of small yellow flowers.

Periwinkle or Trailing Myrtle (*Vinca*) is a European plant which has become naturalized in many states; it is a creeping plant with glossy evergreen leaves and large blue axillary flowers with five broad corolla lobes. Periwinkle is particularly suited for a ground cover in shaded situations under trees, where grass refuses to grow, and on steep stony banks. As an escape, it often completely colonizes shaded roadside banks with its dense cover of rich green leaves and blue flowers.



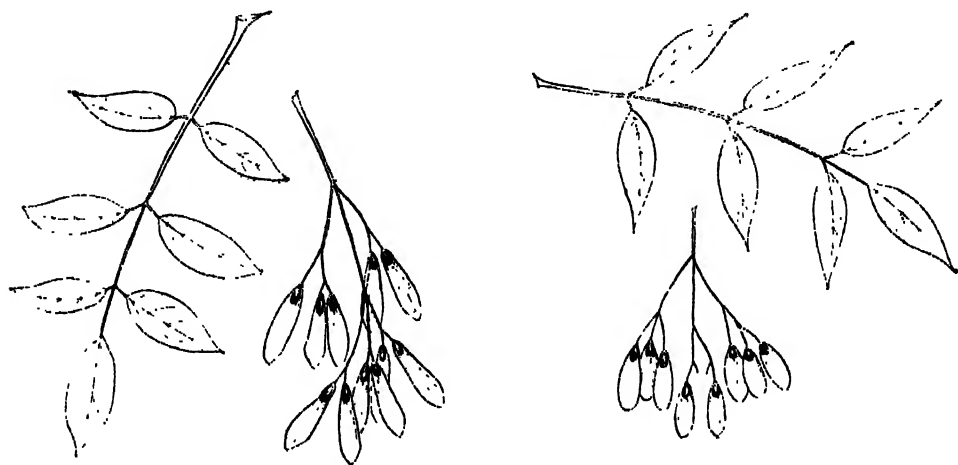
GENTIANACEAE

Floating Heart (*upper left*), American Columbo (*lower left*), Buckbean (*lower right*), Pennywort (*upper right*).

Oleanders (*Nerium*) frequently grow to be fifteen feet high. The dark green, leathery leaves are evergreen and occur commonly in whorls of three; the flowers are borne in large showy clusters of red, white or yellow. Each flower consists of a bell shaped corolla with five broad twisted lobes. The few species in the genus are native to the Old World, from the Mediterranean to Japan. Oleanders are among the most ornamental flowering shrubs in our southern states.

THE GENTIAN FAMILY

The eight hundred species of the Gentian Family (*Gentianaceae*) are widely distributed, but most abundant in the northern hemisphere. They include plants with a colorless but bitter juice, generally opposite and simple leaves, and flowers with a four- or five-lobed calyx and corolla. Our native representatives of the family, in addition to the familiar Gentians, are the Marsh Pinks, Centaury, Floating Heart, Pennywort and Buckbean.



OLEACEAE

White Ash and Arizona Ash.

There are about a dozen species of Gentians (*Gentiana*) in our eastern and central states, with a few more on the Pacific coast. The conspicuous corolla is usually four- or five-lobed, with intermediate pleated folds bearing toothed projections. The beautiful Fringed Gentian, ranging from Maine to Iowa and Georgia, bears large blue flowers, often two inches in length. Growing singly at the tips of the erect branches, each flower has a bell shaped erect corolla divided into four long segments, fringed at their margins and often twisted about each other. Stiff Gentian or Agnweed has smaller pale blue flowers in dense clusters, the corolla of each flower divided into five triangular unfringed lobes; it lives on moist hillsides from Maine to Illinois and Florida. The familiar Closed or Bottle Gentian (*Dasystephania*) is a stout plant of moist woods from New England to Georgia and Nebraska, with blue flowers in axillary and terminal clusters; each flower is club shaped and nearly closed at the top, with the individual corolla lobes quite indistinct. The closely related Soapwort Gentian, another species of the same genus, with more distinctly lobed blue flowers, is found in moist woods over the same range.

The Marsh Pinks (*Sabatia*) are slender plants with linear or oval leaves, found in wet pinelands and brackish marshes of our eastern states. The white or pink flowers are borne in clusters, each flower with a wheel shaped corolla divided into four to

twelve lobes. The common Marsh Pink found in salt meadows from Massachusetts to Florida has pink flowers with five spreading lobes, each with a yellow "eye". The Large Marsh Pink is also a salt marsh plant, with eight to twelve corolla segments.

Centaury (*Centaureum*) is a genus of low-growing plants with ovate leaves and clusters of white, pink or purple flowers; several native species are found in the south-eastern states, and a few more on the Pacific coast. The Spiked Centaury, found naturalized along the Atlantic coast, with white or rose colored flowers arranged along one side of the flowering branch, is a European species; as is also the Common Centaury with rose-purple flowers in flat topped clusters.

Green Gentian and American Columbo (*Prasera*) are tall showy plants with thick whorled leaves; the white, yellow or blue flowers, each with four lobes with fringed



OLEACEAE

Fringe Tree, Privet and Olive.

glands on the inner surface, are borne in terminal clusters. Green Gentian, found on the California deserts, has white margined leaves. The eastern American Columbo, found from New York to Wisconsin and southward, has greenish-yellow flowers marked with brown dots.

The remaining native members of the Gentian Family include the Floating Heart, Pennywort and Buckbean. Floating Heart (*Nymphoides*), an aquatic plant of slow streams and ponds of the coastal plain, from New Jersey to Texas, has broad heart-shaped leaves and clusters of five-lobed white flowers. Pennywort (*Obolaria*) is a small purplish-green plant of moist thickets from New Jersey to Texas, many of the leaves being merely dilated scales; the broadly funnel shaped flowers are white, pink or purple, sometimes single as well as in small clusters. Buckbean (*Menyanthes*) has a creeping rootstock from which grow erect compound leaves with three leaflets, and stout flowering stalks bearing clusters of white flowers, each with a hairy five-lobed corolla; it is found in marshes and bogs from New England to the Pacific coast.



Milkweed (*Asclepias*) pods release hundreds of silky-winged seeds every autumn, many of which are borne miles by air currents. Hamilton, New York.

THE OLIVE FAMILY

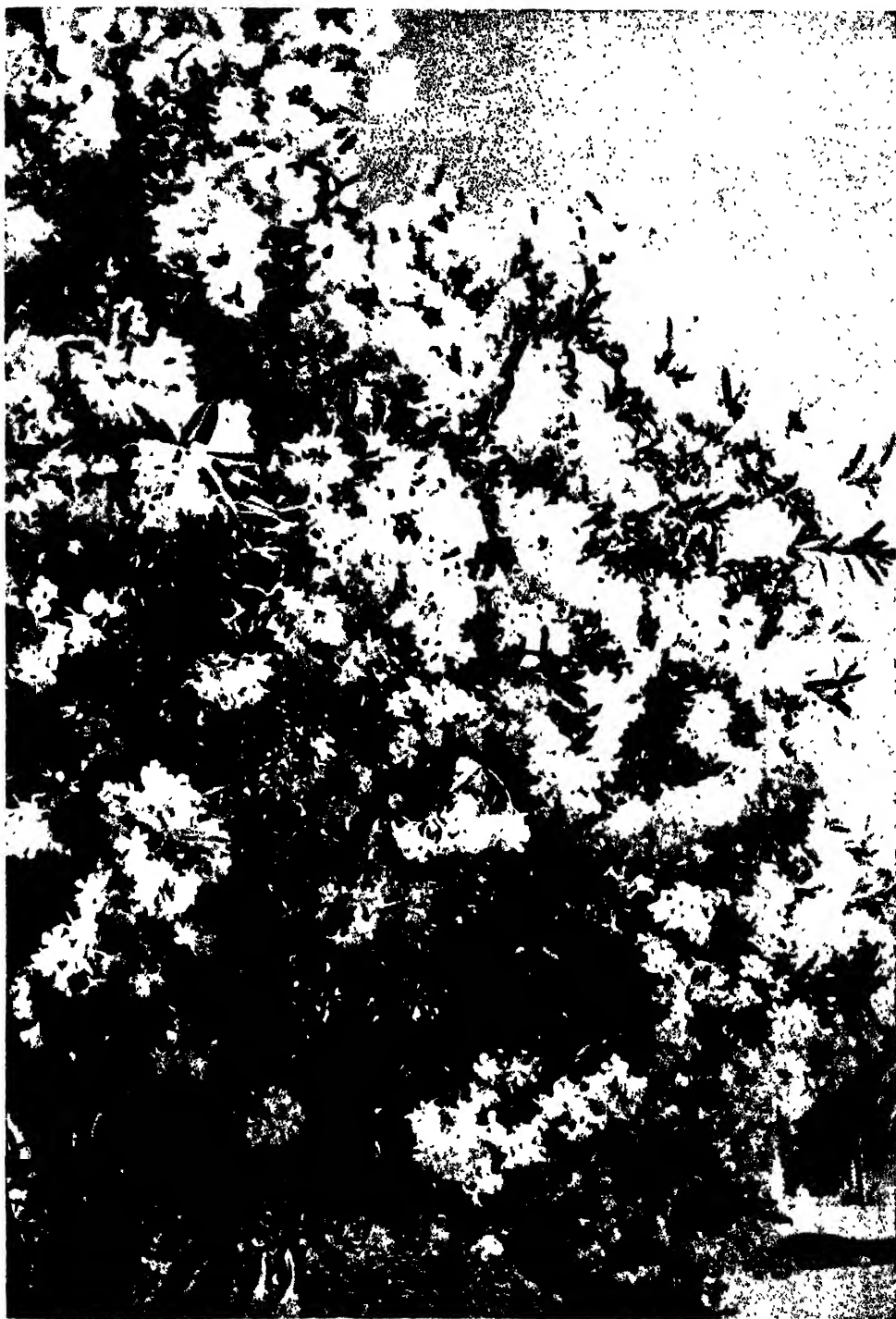
The trees and shrubs which constitute the five hundred species of the Olive Family (*Oleaceae*) are widely distributed in temperate and tropical regions. The flowers have either a small calyx of partly united sepals or none at all, and no corolla or one of two to six partly united petals. In most cases the leaves are opposite, and either simple or compound. Native American members of the family include the Ashes and Fringe Tree; among the introduced ornamental and fruit species are the Olive, Privet, Lilac, Forsythia and Jasmine.



OLEACEAE

Forsythia, Lilac and Jasmine.

The Ashes (*Fraxinus*) are deciduous trees or shrubs with pinnately compound leaves and small greenish flowers in crowded clusters growing from the axils of the previous year's leaves. The fruit has a single narrow terminal wing, an aid in wind dispersal of the seeds. Of the fifty species in the Ash genus, there are a dozen native trees and shrubs. The White Ash is the most valuable tree of the group, its wood being tough, elastic and close-grained—suitable for baseball bats, tennis rackets, oars, bows and various automobile parts. White Ash grows to be a large forest tree in the moist eastern and southern woodlands; the bark is characteristically gray and furrowed, and the compound leaves consist of seven to nine leaflets. Red Ash is a medium-sized tree growing in damp woods from New England to North Carolina and Kansas; it has five to seven leaflets in each compound leaf. Along the river banks and in the swamps of the southeastern states are found the Pumpkin Ash with seven to nine leaflets, growing to a height of a hundred feet; the Water Ash and the Swamp Ash, both smaller trees with five to seven leaflets. In the central states the Blue Ash becomes a large timber tree, its pinnate leaves made up of seven to eleven leaflets and the inner bark used in making a blue dye. West of the Rockies we find several shrubby species; the Flowering Ash of canyon chaparral in California, with white flowers and three to seven leaflets, and the Dwarf Ash, unusual in having simple leaves, ranging



Oleander (*Nerium Oleander*) bushes grow to tree-like proportions in our southern states, and are covered luxuriantly with showy blossoms. Indio, California.

from the Pacific coast to Colorado. Two other western species are small trees; the Arizona Ash, with three to seven leaflets, found in canyons from California to Utah, and the slightly larger Oregon Ash of all the Pacific coast states.

Fringe Tree or Flowering Ash (*Chionanthus*) is a shrubby tree with opposite simple leaves and festooned clusters of white flowers which have narrowly and deeply lobed corollas; this attractive flowering tree inhabits swampy woods and stream banks from New Jersey to Texas and Missouri.

The Olive Tree (*Olea*) is a small evergreen of the Mediterranean region with narrow leaves, often rusty haired on their undersurface, and inconspicuous greenish-white flowers in spreading clusters. The stone-fruit is the olive of commerce. Wild Olives are especially abundant in Algeria and Syria; cultivated varieties have been grown in Asia Minor since prehistoric times. In the United States Olive trees are grown successfully in California, and to a lesser extent in Florida and Arizona; the first trees were planted at the mission in San Diego, by the Spanish padres. The best orchards occur on the hillsides and mountain slopes of central and southern California where some thirty thousand acres are under cultivation. Olives, unlike most fruits, are rarely eaten fresh because of their bitter flavor. Much of the fruit is picked before ripe, treated with lye or soda and then pickled in salt solution; if left to ripen before pickling, the resulting fruits are black instead of yellowish green. The making of olive oil is an important aspect of the olive growing industry. •

Privet (*Ligustrum*) a genus with some fifty species of deciduous or evergreen shrubs native to Europe, eastern Asia and northern Africa, bear leaves which are short stemmed, small and opposite each other. The white or green flowers, with funnel shaped four-lobed corollas, grow in clusters. Because of their compact habit of growth, Privet has long been a favorite plant for hedges.

Two very familiar flowering shrubs of the eastern lawns and gardens are Golden Bells and Lilac. Golden Bells (*Forsythia*) were given their scientific name in honor of William Forsyth, director of the Royal Botanical Garden at Kensington; they are shrubs producing axillary sunny yellow flowers, each with a deeply four-lobed corolla, appearing before the leaves. There are four species, native to China, Japan and southern Europe. Lilac (*Syringa*) is an old favorite in eastern yards and gardens, with its fragrant large clusters of light purple or white flowers. Each flower has a cylindrical, four-lobed corolla. There are thirty species native to Europe and Asia, with many single and double flowered garden varieties. Lilacs are grown especially as cut-flowers in France and England.

Jasmine or Jessamine (*Jasminum*) is an attractively flowered vine or shrub with pinnate leaves and a four- to nine-lobed corolla, with two hundred species distributed through Africa, Asia and Europe. Spanish Jessamine is a white flowered species naturalized in Florida. The Yellow Jasmine of Persia is often cultivated in the southern states. Among the Chinese, Jasmine is used in flavoring tea.

THE LOGANIA FAMILY

The Logania Family (*Loganiaceae*) is a large assemblage (five hundred species) of mainly tropical plants, some of which are of economic importance. There are only a few native representatives of the family. False Jessamine (*Gelsemium*) is a high climbing vine found from Virginia to Texas, covering fences, trees and houses with

festoons of bright yellow flowers. Each flower is broadly funnel shaped and five-lobed. The poisonous root is used medicinally. Indian Pink (*Spigelia*) is a small and rather rare herbaceous plant with spike-like clusters of five-lobed red flowers, marked with yellow on the inside of the corolla; it grows in rich woods from Ohio and Florida to Texas. Its roots are also supposed to be of medicinal value.

Butterfly Bush (*Buddleia*) is an ornamental introduced member of the family, native to the tropics of America, Asia and Africa; it produces showy Lilac-like clusters of violet, yellow or white flowers.

The drug strychnine comes from the seeds of a small tree of India (*Strychnos*). Another species of the same genus, found in South America, is the source of the drug curare and of the arrow poisons used by native tribes. An East Indian species yields a poison used as a snake antidote.

Morning Glory, Mint and Related Families

IN SOME of the families of sympetalous plants the fusion of the petals results in a trumpet or funnel shaped flower with a long tubular portion which expands to form an entire or lobed margin. Frequently the lobes form a two lipped flower, that is, two of the lobes grow more or less upward and erect or arch over the rest of the



CONVOLVULACEAE

Wild Potato Vine (*left*), Sweet Potato leaves, flower section and roots

flower, while the other three lobes grow downwards and form a "posterior" lip to the flower. These families are grouped in one of the largest plant orders, known as the *Labiatae*, they are for the most part small herbaceous plants, very few of the species attaining the size of shrubs or trees. The order includes, among others, the Morning Glory, Phlox, Borage, Verbena, Mint, Nightshade, Figwort, Bignonia and Ocotillo Families.

THE MORNING GLORY FAMILY

Most of the thousand species included in the Morning Glory Family (*Convolvulaceae*) are trailing or twining weak stemmed plants, widely distributed through temperate

regions with a few trees and shrubs in the tropics. The solitary or clustered flowers are made up of five more or less united sepals and a five-lobed funnel shaped corolla. The Morning Glories, Bindweeds, Alkali Weed and *Dichondra* are native representatives of the family; while the Sweet Potato is the only cultivated species of any economic importance.

Morning Glory (*Ipomoea*) is a large genus of tropical vines, mostly Mexican, with a few native species and many naturalized ones; all have large colorful flowers



POLEMONIACEAE

Garden Phlox (upper left), Moss Phlox (lower left), Scarlet Gilia (center), Jacob's Ladder (right).

of red, purple, blue, yellow or white, with an entire or slightly lobed margin. The common Morning Glory, a native of tropical America, has heart-shaped leaves and white or purple flowers; it is a favorite rapidly growing vine used for covering walls, porches and trellises. This Morning Glory is frequently found as an escaped plant throughout the entire United States. Cypress Vine is another tropical American species, with red flowers and leaves pinnately divided into narrow parallel lobes. One of the native eastern species is Wild Potato Vine, a perennial of dry ground in the eastern states; the broadly funnel shaped flowers are white with a purple throat. In Arizona and Texas grows a Wild Morning Glory with three-lobed heart shaped leaves and purple flowers.

The sweet potato comes from another species of the Morning Glory genus which

is a twining and trailing plant with edible starchy roots. Originally native to Central America, it was first discovered in Cuba and the West Indies, and brought from there to Europe in the sixteenth century. It is now widely cultivated throughout Asia also. Being a tropical plant, it can be grown only in our southern states. Some of the watery

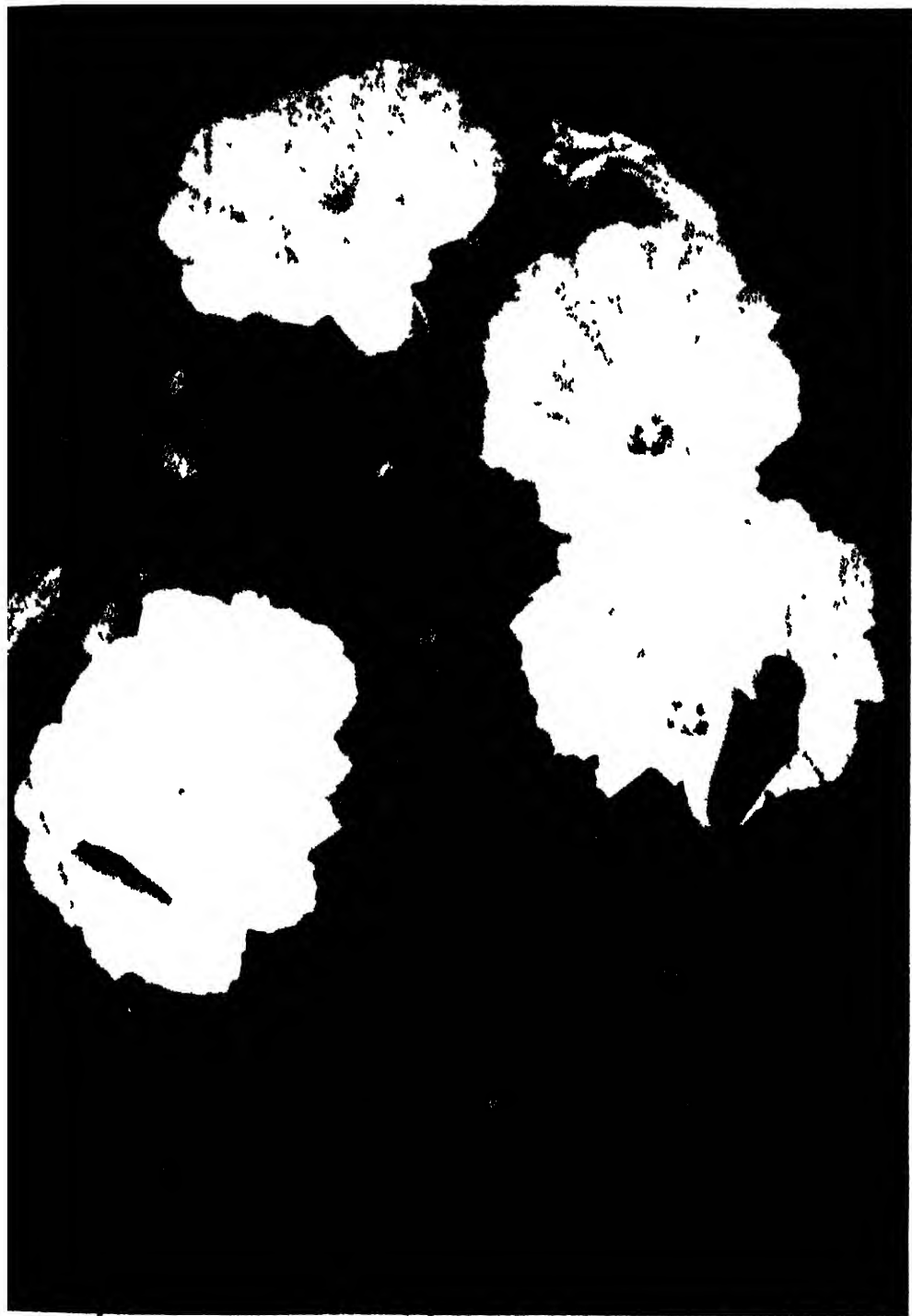


BORAGINACEAE

Hound's Tongue (*upper left*), Virginia Cowslip (*lower left*), Blueweed (*center*), Forget-me-not (*lower right*).

varieties are known as "yams", which however are not the same as the true Yam (*Dioscorea*) which is related to the Lilies.

The trailing Bindweeds (*Convolvulus*) closely resemble Morning Glories, differentiated from them by rather technical botanical characters. The common Hedge Bindweed, a vine with triangular, pointed leaves and white or pink flowers, frequently covers roadside fences and stonewalls. Upright Bindweed is a more erect plant with



Bindweed (*Convolvulus sepium*) is a brightly flowered vine which is found along many eastern roadsides. Penobscot Bay, Maine.

ascending stems and white flowers; it is found in dry rocky woods and fields from New England to Florida. Six more species are native to the southeastern states. Along sandy sea beaches from California to Washington is the purple or pink flowered Beach Morning Glory; while restricted to California is the white or cream colored Western Bindweed. These are but two of a dozen western species.

Alkali Weed (*Cressa*) is a grayish plant with solitary white flowers in the axils of the upper leaves, growing in saline and alkali habitats from Texas and Utah westwards.

The Eastern Dichondra (*Dichondra*), a prostrate creeping plant with kidney shaped leaves and small yellowish or white flowers, grows in wet ground along the



BORAGINACEAE

Seaside Heliotrope, garden Heliotrope, Fiddleneck.

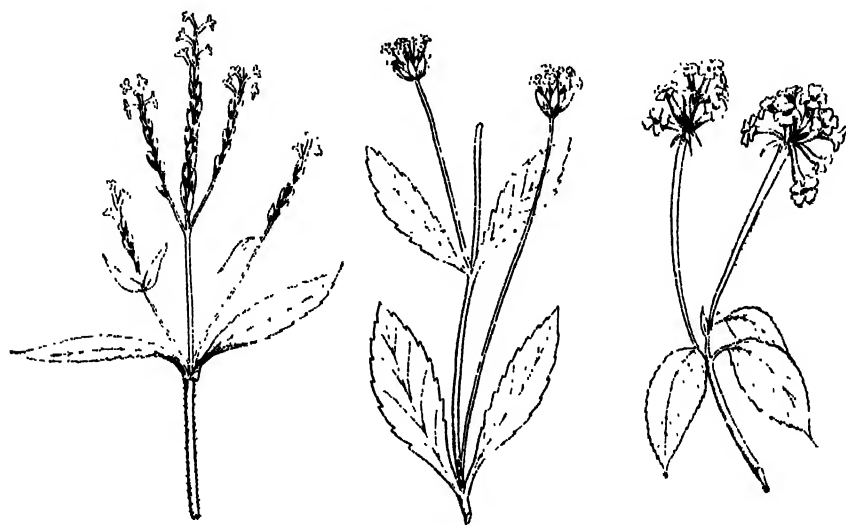
coast from Virginia to Texas. Western Dichondra, with purple flowers, grows with partly buried stems in sandy soil along the California seacoast.

THE PHLOX FAMILY

The Phlox Family (*Polemoniaceae*) includes about three hundred species of herbaceous plants, most abundant in western North America. The flowers have a calyx of five partly united sepals and a five-parted corolla.

Phlox (*Phlox*) is a genus of dwarf shrubs and herbaceous plants with opposite entire leaves; of fifty North American species over a dozen are common in eastern and southeastern United States, and four others are found west of the Rocky Mountains. Woody stems and a prostrate evergreen habit are characteristic of the eastern species Moss Phlox, Sand Phlox and Trailing Phlox. Moss Phlox or Ground Pink, a densely tufted plant, forms a matted growth on bare sandy slopes from New England southward; the pink or white flowers have a five-lobed corolla, the lobes often being indented at the tip. Sand Phlox is another trailing matted plant, found on rocky slopes and cliffs from Tennessee to Iowa and Oklahoma; the flowers are lavender or white. Trailing Phlox, with light purple or white flowers, is of similar aspect, found in oak or pine woods from Virginia to Alabama. The herbaceous and more erect plants

include a variety of species, many of them common garden annuals. The Blue Phlox of rich woods from New England to Nebraska and Texas has a blue corolla with notched lobes. Meadow Phlox or Wild Sweet William is found in damp woods from New England to Minnesota; its stems are frequently spotted with purple, and bear pink or purple flowers. Downy or Prairie Phlox is a softly downy plant with white, pink or purple flowers, found throughout the eastern and southern states. Of the few western species, Douglas' Phlox is a matted plant with closely packed narrow leaves and white or pink flowers, ranging from the Rocky Mountains to the Pacific coast. The common annual Garden Phlox, a native of Texas, has showy flat topped clusters of rose-red or purple flowers; it has given rise to many cultivated varieties since the



VERBENACEAE

Blue Vervain, Lemon Verbena and *Lantana*.

first seeds were sent to England in 1835. The summer Perennial Garden Phlox with white or pink flowers is a native of our southeastern woodlands.

Jacob's Ladder (*Polemonium*) grows erectly with pinnately compound leaves, the basal ones divided into eleven to seventeen leaflets; the bluish-purple flowers are borne in terminal clusters, each flower being bell shaped with five rounded lobes. This representative of the Phlox Family grows in swamps and marshy meadows of the northeastern states. Bluebell Valerian, a species widely distributed in the eastern states, has a weak reclining stem and nodding pale violet flowers.

Prickly Phlox (*Gilia*) is one of over fifty species in this common western genus; it is an erect widely branched shrub with prickly palmately lobed leaves and dense clusters of pink flowers, growing in chaparral of southern California. Ground Pink is another Californian species, characterized by thread-like leaves and pink, dark spotted flowers with yellow throat. Skyrocket or Scarlet Gilia, found throughout the western states, has a basal rosette of leaves divided into linear segments and terminal clusters of scarlet flowers.

THE BORAGE FAMILY

The Borage Family (*Boraginaceae*) is a large one, including fifteen hundred species of herbs (shrubs and trees in the tropics) of world-wide distribution. They are rough hairy plants, with the five-parted calyx and five-lobed corolla found in the other *Tubiflorae* families. Native wild flowers include Virginia Cowslip, Lungwort, Forget-me-not, Wild Comfrey, Bui-seed, Gromwell, Heliotrope, Fiddle-neck, White Forget-me-not and Popcornflower.

Virginia Cowslip (*Mercurialis*) is a stout stemmed, blunt leaved plant found in



SOLANACEAE

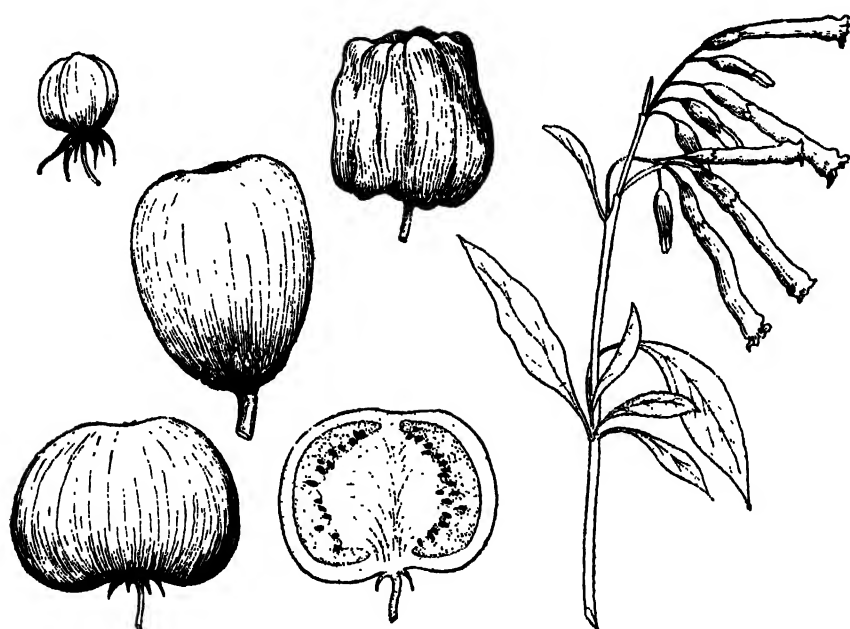
Ground Cherry (*upper left*), Petunia (*lower left*), Jimson Weed (*right*).

wet meadows and along stream margins from New England to the Gulf of Mexico and Kansas. The bluish flowers are borne in terminal clusters, each trumpet-shaped flower has a long tube and a cupped margin which is shallowly five-lobed. Western Lungwort, another species, grows from California to Washington, it is a similar plant with blue flowers.

Forget-me-not (*Myosotis*) is a slender plant usually found growing in brooks and wet meadows of most of the eastern states. The small and delicate blue flowers have five rounded lobes, each marked with a yellow "eye". It is considered by some

botanists to be a native of Europe; if so, it has become thoroughly naturalized over a large portion of the United States. Most of the Forget-me-not species are natives of Europe, many of them found as escaped plants in our eastern states. Of our three native species, the White Forget-me-not is found on dry rocky banks of the eastern states.

Several other European plants have become well established in the United States. Blueweed or Viper's Bugloss (*Echium*) has made itself at home in our eastern and southern states; it is a bristly weed with spotted stems and blue flowers with unequally lobed corollas and projecting red stamens. Hound's Tongue (*Cynoglossum*) has also become a weed in pastures and waste ground; the stems are hairy, often with an un-



SOLANACEAE

Fruits of various members of the family--potato (upper left), pepper (upper right), eggplant (center), tomato (bottom). Tree Tobacco (right).

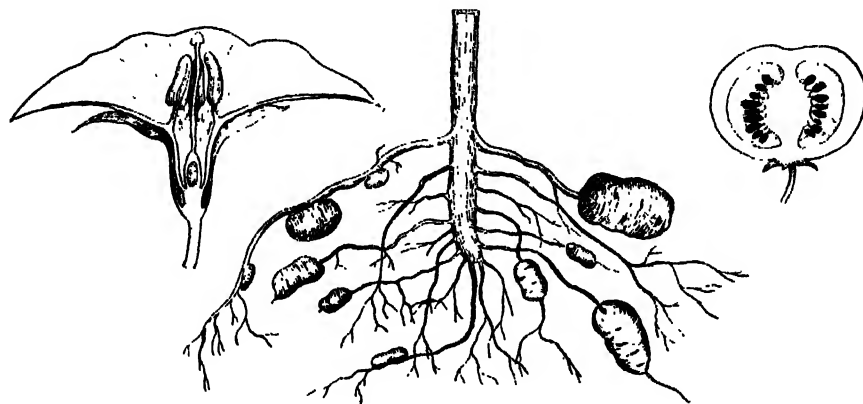
pleasant odor, and bear branched clusters of reddish purple flowers. Wild Comfrey is a native species of the same genus, with blue or white flowers; it grows along roadsides and in dry woods from New Jersey to Kansas and Louisiana.

Bur-seed or Beggar's Lice (*Lappula*) a hairy grayish plant, has small pale blue or white flowers, each with a deeply five-lobed corolla. It grows along roadsides and in thickets from New England to the Gulf and the prairies.

Gromwell (*Lithospermum*) is a loosely branched plant with greenish-white or yellow flowers whose corollas are shorter than the sepals; it is found in open ground throughout the eastern states. Puccoon, a related species with large deep orange

flowers, occurs commonly in the plains and open woods of the central and eastern states.

Heliotrope (*Heliotropium*) is a genus with over two hundred species, common to the warmer countries; often it is noticeably fragrant. Our few native members include Seaside Heliotrope with narrowly linear leaves and small white or bluish flowers, growing on sandy seashores and salt marshes of the Atlantic coast, and on saline soil from California to Utah and Nevada. Prairie Heliotrope, with white flowers, grows on dry ground of the central and southern states. Chinese Pusley is a desert plant of California and Arizona, with white flowers scattered along the leafy stems. Many of the garden varieties of Heliotrope are derived from a Peruvian species.



SOLANACEAE

Potato—flower section, tubers and fruit section.

Three genera are especially abundant in the western states. Fiddleneck or Yellow Forget-me-not (*Amsinckia*) grows in arid sandy regions from California to Utah and Washington; the stems are bristly and support characteristically one-sided clusters of bright yellow flowers. These stems are curled at the tip but uncoil as the flowers mature. White Forget-me-not (*Cryptantha*) has white flowers in similar one-sided clusters, and grows in sandy and gravelly locations from California to Texas. Popcornflower (*Plagiobothrys*) is a weak slender herb with clusters of white flowers, partial to moist ground such as is found about lake margins.

THE VERVAIN FAMILY

In the Vervain or Verbena Family (*Verbenaceae*) are about a thousand species of herbs and shrubs of which we have only a few representatives native to the United States. They often have angled stems, opposite leaves and flowers with a four- or five-lobed, sometimes two-lipped, corolla.

The Vervains (*Verbena*) are mainly American plants, with over a dozen species in the eastern and southern states and slightly fewer in the West. Blue Vervain grows in moist fields and meadows throughout most of the country east of the Rocky Moun-

tains. The violet blue flowers, each with a five-lobed corolla, are borne in terminal spikes. White Vervain is found in similar moist habitats from New England to the plains. On barren and grassy ground of the central states grows a Hoary Vervain, covered with downy white hairs and producing clustered large purple flowers. The Common Vervain of the Pacific coast states also has blue flowers, in interrupted terminal clusters; it grows in dry places at low altitudes.

Lemon Verbena (*Lippia*), also known as Mat Grass, ranges from the Atlantic coast to southern California; the creeping stems bear thick wedge shaped leaves and axillary heads of rose-purple or white flowers. Fog Fruit of the central and southern states, with bluish-white flowers, is another species of the same genus, usually found along river banks.



SCROPHULARIACEAE

Square-stemmed Monkey Flower, Turtlehead and Brooklime.

French Mulberry (*Callicarpa*), a member of the Vervain Family, becomes more of a shrub; its leaves are hairy white on the undersurface and the blue flowers tubular or bell shaped, with a four- or five-lobed margin. It is found in rich soil from Virginia to Texas.

Various species of *Lantana*, natives of the American tropics, are common flowering shrubs in our southern states; the small red or orange flowers are in showy clusters, each flower with a tubular and four- or five-lobed corolla.

THE MINT FAMILY

The Mint Family (*Labiatae*) numbers among its members some three thousand species of usually aromatic square stemmed herbs and shrubs with opposite or whorled leaves; the flowers often some shade of blue or purple, are two-lipped, the

upper lip divided into two lobes and the lower one into three. The fruits are groups of small nutlets. Only two shrubby species are native, the Bladder Sage and the Desert Lavender. Native flowers include the Germanders, Blue Curls, Skullcaps, Hyssops, Dragonhead, Sages, Bergamots, Mock Pennyroyal, Water Horehound, Mountain Mints, Mints and Horsebalm. Many Eurasian members of the family have become so well established that they are often thought of as native species; such are Heal All,



SCROPHULARIACEAE

Beardtongue (lower left), Chinese Houses, Wood Betony (center), Owl's Clover (upper right), Painted Cup (lower right).

Horehound, Catnip, Gill-o'-er-the-Ground, Lemon Balm, Henbit, Lion's Ear, Motherwort, Basilweed, and Creeping Thyme.

Hairy Germander (*Teucrium*) is erect and hairy with dense terminal clusters of purplish flowers whose short tubed corollas each have short upper lobes and broader lower ones; it grows in moist woods from New England to Pennsylvania and New Mexico. American Germander or Wood Sage is a similar plant of the northeastern and north central states, with a less hairy calyx and flower bracts. The pale blue flowers of Western Germander, found from Texas to California, form long tapering clusters in the axils of the leaves.

Blue Curls (*Trichostema*) is a slender plant with blue or pinkish flowers; the bell shaped corolla is deeply five-lobed, the upper lobes being much larger and more united than the lower ones. It is found in dry sandy fields from New England to Texas. Of

the half dozen western species, Vinegar Weed has bright blue flowers, and is found in dry fields from California to Washington.

Skullcaps (*Scutellaria*) constitute a fairly large genus of bitter rather than aromatic plants. Blue Skullcap or Mad Dog, inhabiting wet marshy meadows from New England to New Mexico, has coarsely toothed, pointed leaves and blue flowers in terminal or axillary one-sided clusters. The lips of the corolla are of equal size, the



SCROPHULARIACEAE

Moth Mullein, Fern-leaved False Foxglove, and Butter-and-Eggs.

upper one arched. Hooded or Marsh Skullcap, found in the same area and habitat, has narrower leaves and large blue solitary flowers, appearing paired, in the axils of the upper leaves. Of the western species, the Western Blue Skullcap, with broadly oval leaves and few purplish flowers, is found on dry slopes of all the Pacific coast states. California Skullcap, with yellow or white flowers, prefers the sunny open hillsides of California.

Giant Hyssop (*Agastache*) is a tall perennial with greenish-yellow flowers in dense clusters, each flower has a five-lobed calyx and a corolla with erect upper lip and spreading lower one; it grows on hillsides and in woods from New England to Georgia and Minnesota. Other species have blue or purple flowers. Western Hyssop, a violet flowered member of the genus, grows along stream margins in the Pacific

coast states. The European Hyssop (*Hyssopus*), occasionally found as a naturalized plant in the eastern and southern states, has blue or purple flowers in axillary clusters. Each flower has a notched upper lip and a three-lobed lower one, the middle lobe being divided again into two segments.

Dragonhead (*Dracoccephalum*) is a genus of North American plants whose arched upper lip and spreading lower one resemble the face of an animal, fancifully considered dragon-like. The rather narrow leaves are opposite each other, and the pink or rose-colored flowers grow in dense terminal spikes. Each flower has an entire upper lip and a three-lobed lower one with the middle lobe again subdivided. Dragonhead inhabits swamps and wet woods from New England to Texas and Kansas.



LABIATAE

Blue Curls, Blue Skullcap and Scarlet Salvia.

The Sages (*Salvia*) include five hundred, usually strongly aromatic, species of widely distributed plants whose leaves are often grouped in basal clusters. The flowers grow in whorls, among leafy bracts, with the usual erect upper lip and three-lobed lower one. The Lyre-leaved Sage found in sandy woods from New England west to the prairie states has basal lyre shaped compound leaves and blue flowers. Of the numerous western species, Thistle Sage, common to dry fields of California, is one of the most strikingly beautiful western wild flowers; the lavender corollas are grouped in a terminal head, surrounded by long sharp spine-like bracts, and the middle lobe of each lower lip is delicately fringed. The leaves are spiny and thistle-like. Crimson Sage is another species of grassy California hillsides, with round lobed leaves, hairy white on the underside, and purplish red flowers in crowded cylindrical clusters. Purple Sage is a more shrubby species with purple flowers in heads, found on dry California slopes. Several of the tropical American members of the genus are frequently found in cultivation. The common Scarlet Salvia of Brazil is a popular shrubby species with terminal whorls of showy red flowers. The Blue Salvia of Mexico is a slightly smaller and less common cultivated species.

Oswego Tea or Bee Balm (*Monarda*), one of twenty North American species of the genus, bears dense terminal heads of bright scarlet flowers beneath which are red or partially red bracts. Each flower is two-lipped, the upper one narrow and arched, the lower three-parted with a large middle lobe. It prefers open woods and roadsides, and can be found from New England to Alabama and Michigan. Wild Bergamot, a species with yellowish pink or lilac flowers in similar terminal heads, grows on dry hillsides from New England to Louisiana and Kansas. Purple Bergamot, with showy purple-red flowers, grows in thickets and along stream banks from New England to Virginia and Tennessee. Horsemint is a related species with yellow, purple-spotted flowers, growing in sandy fields and roadsides of our eastern states. Western Horse-



LABIATAE

Oswego Tea, Wild Mint and Heal All.

mint with yellowish-white flowers, is the sole representative in the far western states.

Mock Pennyroyal (*Hedeoma*), found in dry soil from New England to Florida and Kansas, has axillary clusters of purple flowers and small opposite linear leaves. A Western Mock Pennyroyal also has purple flowers, and inhabits dry slopes from California to Nevada and Texas.

Mountain Mint (*Pycnanthemum*) is an aromatic erect herb with whitish leaves and bracts, white or purple-spotted flowers in dense axillary clusters. Of several dozen species, the majority are found in our southeastern states, a few in the central part of the United States. Hoary Mountain Mint, whose white flowers have purple dots, lives in dry woods and hillsides from New England to Missouri and Florida.

Water Horehound or Bugle Weed (*Lycopus*) is a water loving plant of swamps and wet meadows, found from coast to coast; the white flowers are in axillary clusters, each flower bell shaped and slightly two-lipped, the upper one notched and the lower one equally three-lobed.

The Mint genus (*Mentha*) includes many species such as Spearmint and Pepper-

mint with aromatically fragrant foliage used in flavoring extracts; they are plants of north temperate regions, with perhaps a dozen common native or naturalized species. American Wild Mint grows in wet places from New England to Nebraska and North Carolina; its lavender or white flowers grow in small axillary whorls, the funnel shaped corolla nearly regular and four-lobed, with the upper lobe slightly larger than the rest and notched. Pennyroyal, a European species naturalized in California, has grayish leaves and whorls of flowers in the axils of the leaves. Spearmint, another European species, with purple stems and narrow interrupted spikes of lavender flowers, has become naturalized throughout the United States. Peppermint has light violet colored flowers in thicker, denser spikes.



LABIATAE

Horehound, Catnip and Field Basil.

Horsebalm or Stoneroot (*Collinsonia*), found in rich woods and thickets from New England to Arkansas and Kansas, has yellow lemon scented flowers in terminal branched clusters. The lower lip of the flower has an ornately fringed middle lobe.

Bladder Sage (*Salazaria*) is a spiny, densely branched shrub of the southwestern deserts; the purple flowers have arched upper lips and lower ones with recurved sides and short lateral lobes. Desert Lavender (*Hyptis*), American representative of three hundred tropical species, is a fragrant and whitish-green shrub with axillary clusters of violet flowers, found also in the Southwest. The flowers have a woolly calyx and a corolla with a three-lobed sac-like lower lip. A related species lives in swamps and marshes from Florida to Texas.

Many of the Eurasian members of the Mint Family have been grown for generations in American herb gardens; some of these have escaped and become naturalized in many of our states. Others have been introduced by chance and have become weeds. Heal All (*Prunella*) is a common wild flower of fields and meadows, originally from Europe; the small blue flowers, intermingled with green bracts, grow in a dense cylindrical head, each corolla with an arched and entire upper lip. Horehound (*Mar-*

rubium) is well known as flavoring used in making cough medicines and candies; the calyx of the plant is prominently ribbed and edged with small lobes, surmounted by a white flower with erect upper lip and spreading lower one. Catnip (*Nepeta*) is valued for its pungently aromatic foliage, which is hairy white on the underside; the flowers are white with magenta spots, and borne in axillary clusters. The lower lip of the corolla has a spreading toothed middle lobe. Gill-o'er-the-Ground (*Glechoma*), a creeping plant with rounded leaves and light blue small flowers in axillary clusters, often forms extensive mats in waste fields and pastures. Lemon Balm (*Melissa*) has axillary clusters of white or cream flowers with an inflated upper lip and a three-lobed lower one with bearded base. Henbit (*Lamium*) is a spreading plant with rounded



BIGNONIACEAE

Catalpa and Desert Willow.

leaves and axillary whorls of blue or purple flowers. Lion's Ear (*Lionotus*), a native of South Africa, has become naturalized in the southern and Pacific coast states; it is a coarse tall plant with orange-yellow or scarlet flowers in spherical clusters. The individual flowers are curved and have the lower lip of the corolla shorter than the upper one. Motherwort (*Leonurus*) is one of several naturalized European species of the genus; it has axillary clusters of pale purple flowers, with a hairy corolla, conspicuous for its large erect upper lip. Field Basil or Basilweed (*Clinopodium*) is a common slender stemmed plant with dense axillary whorls of pink, lavender or white flowers, each with a large erect upper lip and a three-lobed spreading lower one. It has a few native relatives in the southeastern states. The fragrant European Creeping Thyme (*Thymus*) forms a low matted growth with axillary clusters of purplish flowers with equally lobed three-parted lower lips.

THE NIGHTSHADE FAMILY

The Nightshade Family (*Solanaceae*) includes about seventeen hundred species of herbs, vines and shrubs—well represented in the tropics. They are best known for the

narcotic and poisonous compounds found in some of the species (Belladonna, Jimson Weed, Deadly Nightshade, Tobacco) and the edible portions of others (Potato, Eggplant, Tomato, Paprika, Cayenne, Red Pepper). Native wild flowers in the family are the Ground Cherry, Husk Tomato, Wild Potato, Bull and Horse Nettle and Wild Tobacco; cultivated members include the Petunias.

Ground Cherry (*Physalis*) is one of a large genus of plants, chiefly American, with several dozen species common to the southeastern and central states; their nodding flowers are usually solitary, in the axils of the leaves. Clammy Ground Cherry has thick heart-shaped leaves, a hairy five-lobed calyx and a greenish-yellow bell-shaped corolla with dark brown center. It is found in rich woods from New England to Texas and Utah. Husk Tomato of southeastern and southwestern United States is a related species with yellow flowers conspicuous for their purple stamens.

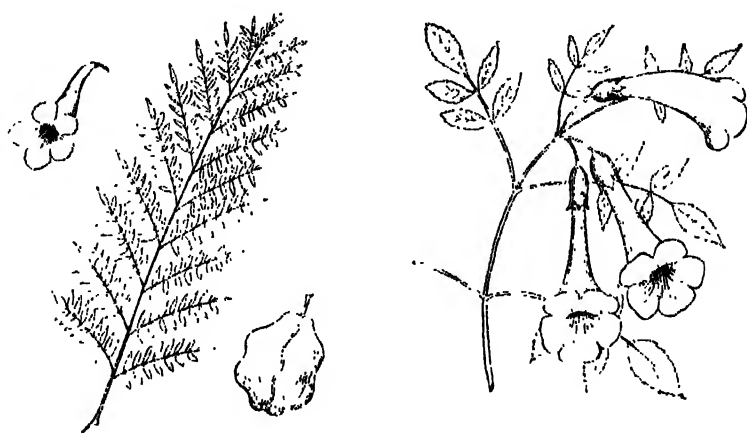
The Nightshades (*Solanum*) are herbs, vines and a few trees with five-lobed flowers of various colors; they include a thousand or more species, most abundant in tropical America. Climbing or Bittersweet Nightshade is a European vine, naturalized in our eastern and central states, with entire or lobed leaves and drooping clusters of blue or white flowers whose triangular lobes are distinctly recurved. The fruits are red berries. Deadly Nightshade is a ubiquitous weed, originally native to Europe, with white or bluish flowers and black berries. Horse Nettle or Sand Brier, Wild Potato and Bull Nettle are native representatives of the genus. Horse Nettle is a prickly-stemmed plant ranging from New England to Florida and Texas, with violet flowers and orange-yellow berries. Jerusalem Cherry is a European species with white flowers and globular scarlet (sometimes orange) berries.

Cultivated members of the *Solanum* genus include the White Potato and the Eggplant. The White Potato, native of western South America, was cultivated in Chile and Peru before the arrival of the Spanish explorers, who found the natives using the tubers as the principle article of their diet. In the sixteenth century the potato was introduced into Europe via Spain, and from there the culture spread to England and Ireland; being eventually brought back to the continent which was its native home by the English colonists. The Potato Plant has pinnately compound leaves and flowers of various colors from white, pink, yellow and blue; the foliage has the narcotic smell characteristic of tobacco and tomato. Its most important feature is the formation of swollen portions of the underground stem, known as tubers, which are in reality storage organs filled with starchy and protein substances. The "eyes" of the tubers are the buds, since the potato tuber is a stem and not a root. Potatoes are usually propagated by sections of the tubers, unless new varieties are desired. There are today five hundred different cultivated varieties, many of them with far larger tubers than were found on the original wild potatoes. Potato plants often flower but seldom form fruit with fertile seeds, perhaps because of the long continued dependence upon vegetative means of reproduction by tubers. When it does form, the fruit is a brown or purplish-green globular berry with seeds imbedded in a green pulp. In addition to being used as a food—for which purpose potatoes rank second only to the cereal grains—they are made into starch and alcohol. Eggplant is another species of *Solanum*, native to India; it is a somewhat woody herbaceous plant with large lobed leaves, grown in tropical countries. The fruit is among the largest in the family, being

a gigantic pear-shaped berry often six inches in diameter. The fruits are boiled entire or sliced and fried.

Jimson Weed or Thorn Apple (*Datura*), a native of tropical America and Asia, is a shrubby herb with large funnel-shaped flowers which are borne solitary and erect in the leaf axils and vary in color from white to violet and lavender. The fruit is a prickly capsule. This is a poisonous plant, one of the few common weeds which should be avoided since serious illness results from eating it. Other naturalized species are found in the central, southern and western states.

The Tobaccos (*Nicotiana*) include fifty species of tropical American plants with hairy and sticky stems and large simple leaves. The scientific name for the genus commemorates Jean Nicot, French consul to Portugal, who introduced tobacco to



BIGNONIACEAE

Jacaranda and Trumpet Creeper.

the courts of both those nations. Tobacco is a vigorous growing annual reaching a height of five feet, its leaves containing the narcotic drug nicotine. The flowers are large, funnel-shaped and five-lobed, usually greenish or purplish-white in color. Tobacco is perhaps, economically, one of the most important contributions of the New World to man. It was under cultivation by the natives of South America when the first Europeans reached the continent, the leaves being smoked for ceremonial purposes. Today numerous varieties are cultivated on all the continents, in subtropical and temperate climates. When the plants are grown under cloth covering as is done in the Connecticut Valley, the leaves, which are the source of commercial tobacco, are thin and tender; such leaves form the best tobaccos, and are used for outer wrappers of cigars. After the leaves are picked they are allowed to dry in racks in well ventilated barns. Other grades of tobacco are grown in many eastern and southern states, to be used for cigarettes, pipe tobacco, plug tobacco and snuff. That the drug nicotine is also a deadly poison is suggested by the fact that nicotine extract is used in making insecticides. Several other species of Tobacco, cultivated by the American Indians, are sometimes found naturalized in various states. A native species grows in the rocky

canyons of our Southwest. Tree Tobacco is a South American small tree naturalized in Mexico and our Southwest; the long tubular flowers are yellow, with short lobes.

Tomatoes (*Lycopersicum*) are near relatives of the Potato and Tobacco, and like them are natives of South America. The plants have compound leaves and clusters of inconspicuous flowers, each corolla five-parted and wheel-shaped. The tomato fruit is botanically known as a berry, with the seeds buried in fleshy pulp. When first introduced to Europe by the Spaniards it was known as the Love Apple and was cultivated as an ornamental plant, tomatoes being often found on mantelpieces as decorative objects. The fruit was considered inedible because of its poisonous relations in the Nightshade Family; its popularity as a food is relatively recent.

Red Peppers (*Capsicum*) are often confused with the Black or White Peppers which, as we have seen, belong to another family (*Piperaceae*); the Red or Cayenne Peppers are relatives of the Potato and Tomato, with large berry-like fruits, native to tropical America where the fruits have long been the favorite vegetable of the natives. All are pungent due to the presence of a nitrogenous compound known as capsaicin. Pepper fruits are often used entire, in salads; they also are made into Tabasco sauce and, mixed with meat, into Chili con carne. The dried and ground-up fruits are known as Paprika and Cayenne Pepper.

Petunias (*Petunia*) include a dozen South American and a few Mexican species, some of which are the ancestors of the popular garden and potted varieties. The name comes from "petun", a South American aboriginal name originally applied to the tobacco plant. The flowers are white, purple or reddish with a deeply five-parted calyx and a long-tubed corolla which is funnel-shaped and five-lobed.

THE FIGWORT FAMILY

The Figwort Family (*Scrophulariaceae*) is another large family of the Tubiflorae, numbering about three thousand species of herbaceous plants—rarely shrubs or trees—which are widely distributed geographically. The flower consists of a calyx of four or five distinct or united sepals, and an irregular corolla of five partly or wholly united petals, usually two-lipped, the upper lip two-lobed or hooded and the lower three-lobed and spreading. Native wild flowers in the family include Hedge Hyssop, False Pimpernel, Monkey Flowers, Turtleheads, Beardtongues, Figworts, Innocence, Chinese Houses, Culvers Root, Speedwells, False Foxgloves, Gerardias, Blue Hearts, Indian Paint Brush, Owl's Clover, Wood Betony, Rattlebox and Eyebright. From some of these come cultivated varieties found in our gardens. Introduced and naturalized flowers include the Mullens and Butter-and-Eggs.

Hedge Hyssop (*Gratiola*) occurs commonly in wet woods or muddy habitats throughout most of the states; it is a somewhat succulent plant with solitary flowers in the axils of leaf-like bracts which are longer than the calyx lobes. The cylindrical white or light yellow corolla has some of the lobes united almost to the tip of the flower. Golden Hedge Hyssop with bright yellow flowers grows in sandy wet places from New England to Virginia.

False Pimpernel (*Hyssanthus*) is a creeping wiry stemmed plant found in swampy places from New England to Texas and North Dakota. The flowers, white or tinted with lavender, are solitary in the leaf axils, with arched and partly fused upper lobes and lower ones with yellow hairy ridges.



Mullein (*Verbascum*) is a Eurasian plant which has thoroughly established itself along our roadsides and in fields and meadows Penobscot Bay, Maine

The Monkey Flowers (*Mimulus*) are chiefly American species, most of them occurring west of the Rocky Mountains. They are herbaceous plants with opposite simple leaves and blue or purple flowers in the axils of leaf-like bracts. Square-stemmed Monkey Flower ranges from New England to Colorado and Minnesota, inhabiting marshes and wet meadows; the flower calyx is five-angled and five-toothed, and the corolla has an upper reflexed lip and a lower spreading one. Musk Flower is slimy and hairy, a creeping species with yellow funnel-shaped flowers which also prefers wet places but ranges from New England to California. Of the strictly western species, the Western Monkey Flower has a bright yellow corolla which is sometimes spotted with red; it grows in wet places from the Rocky Mountains to the Pacific coast.

The Turtleheads (*Chelone*) are a small genus of eastern North American flowers with sepal-like bracts beneath the flowers. The corolla is white (sometimes purple or green) and two-lipped, the upper lip concave and inflated with a slightly lobed lower lip; the general appearance being that of a turtle's beaked profile. White Turtlehead with its flowers in a dense terminal spike grows in swamps and wet places from New England to Alabama and Kansas. Purple Turtlehead is also a swamp plant, found on the coastal plain from Maryland to Florida, and in the lower Mississippi Valley.

Beardtongues (*Penstemon*) make up a large North American genus (some three hundred species) with at least forty common species west of the Rocky Mountains and about half that number in the central and southern states. They are strongly-scented erect plants with opposite leaves and terminal clusters of nodding flowers, each with five sepals and a long tubular corolla terminated by a slightly unequally lobed margin. One stamen is sterile and bearded at its flattened extremity, projecting like a tongue from the throat of the flower. Hairy Beardtongue, a plant of rocky woods from New England to Tennessee and Wisconsin, has downy stems and hairy calyx with purple corolla marked by a white throat. Smooth Beardtongue is a smoother stemmed plant found in meadows and along riverbanks from Pennsylvania to Alabama and Florida, its violet-colored corolla tube enlarged and the inside white with purple lines. Scarlet Bugler is a Californian species found in extensive masses in the grasslands bordering the desert; its scarlet long-tubed flowers grow in showy terminal clusters. Numerous garden varieties of the *Penstemons* are often cultivated.

There are a few eastern and central species of Figworts (*Scrophularia*) and one common western representative. Common Figwort grows in rich woods from New England to Georgia and Kansas; it is a strongly-scented opposite leaved plant with greenish-purple flowers. California Figwort, found in California and Oregon, has small dull red flowers.

Innocence or Blue-eyed Mary (*Collinsia*), found in moist woods from New York to Oklahoma and Minnesota, has narrow opposite or whorled leaves and a two-lipped blue, pink or white corolla; the middle lobe of the lower lip forms a boat-shaped sac which encloses the stamens. Of the numerous western members of the genus, Chinese Houses is a common Californian species, with striking whorls of stemless flowers encircling the terminal portions of the slender erect stems; each corolla has a pale lilac or white upper lip and a violet or purple lower one.

Culver's Root or Bowman's Root (*Veronicastrum*) is found in moist meadows and woods from New England to Texas and Minnesota; it has whorled or opposite



Ocotillo (*Fouquieria splendens*) is a bizarre desert shrub with gray cane-like stems, covered for a short time with small leaves but always armed with stout thorns. Borrego Desert Park, Palm Springs, California.

leaves and terminal wand-like clusters of small white flowers, whose tubular corollas are each divided into four equal lobes.

Speedwell (*Veronica*) includes several hundred species, but only a dozen are common central and eastern plants, even fewer are western. American Brooklime or Common Speedwell which grows in wet places from coast to coast has creeping stems rooting at the nodes, and blue or white flowers, striped with purple, in axillary clusters. The lower lobe of the four-lobed corolla is the narrowest. Neckweed, found from New England to Iowa as well as on the Pacific coast, is a species with white flowers.

The False Foxgloves (*Auricularia*) include about a dozen eastern North American species, with deeply toothed or pinnatifid leaves and yellow funnel-shaped flowers, each with five spreading lobes, in axillary clusters. Fern-leaved False Foxglove has fern-like leaves and short stalked flowers growing singly in the axils of the upper leaves; it is found in dry woods of most of the states east of the Mississippi. Smooth False Foxglove, found in the same area, often has a whitish bloom over its foliage of deeply lobed leaves; the yellow flowers are less spreading at the mouth than those of the preceding species.

The Gerardias or False Purple Foxgloves (*Agalinis*) are slender plants with opposite narrow or scale-like leaves and flowers growing singly in the axils of the leaves. There are some thirty species chiefly distributed through the southeastern and central states. Large Purple Gerardia is found in moist fields and meadows from Maine to Florida, west to Texas and Minnesota; the purple flowers are hairy and slightly two-lipped, the spreading corolla lobes being shorter than the tube. Slender Gerardia with smaller, purple spotted flowers, grows from New England to Michigan, south to the Gulf.

Blue Hearts (*Buchnera*) are attractive little plants with opposite leaves and terminal spikes of slender, deep purple flowers with a hairy curved tubular corolla, terminated by nearly uniform spreading lobes. It is found in meadows and sandy soils from New Jersey to Minnesota and southward.

Conspicuous among the wild flowers of early summer are the Indian Paint Brushes or Painted Cups (*Castilleja*), a large genus of plants which are partial parasites on the roots of other green plants; they are most abundant in the central and western states. The leaves are alternate, and those immediately beneath the flower cluster are brightly tipped with red or yellow. The corolla and calyx of the flower is flattened, the former being two-lipped. Eastern Painted Cup, a plant of moist meadows and woods from Maine to Arkansas and Kansas, has yellowish-green flowers, one lip of the corolla being long and narrowly arched. Western Indian Paint Brush of California has showy red flowers with both calyx and corolla brightly colored.

Of the numerous western species which frequently color square miles of hillsides with their showy flowers, Owl's Clover (*Orthocarpus*) is one of the most attractive; there are some two dozen western species, one of which ranges eastward into the prairie states. The upper leaves, like those of Indian Paint Brush, are colored and grade into the bracts of the compact head of small flowers, each with a yellow or purple corolla with three purple spots on the inflated and conspicuous lower lip.

Wood Betony (*Pedicularis*) is a common eastern member of the Figwort Family, whose three hundred related species are chiefly Old World residents. It has a basal tuft of pinnately lobed leaves, often mistaken for those of a fern; peeping out from

amid the dense ferny foliage are compact heads of yellowish-brown flowers each with a toothed and arched upper lip and a spreading three-lobed lower one. Wood Betony likes to grow in sandy sunny situations, from New England to Texas and South Dakota.

Rattlebox or Yellow Rattle (*Rhinanthus*) is a cold temperate plant which has migrated into thickets and meadows of our northern tier of states from New England to Washington. The leaves are opposite and toothed or lobed; yellow flowers are borne in terminal one-sided clusters or singly in the axils of the upper leaves, whose lower lip is shorter than the arched upper one. Eyebright (*Euphrasia*) is another subarctic inhabitant of dry soils from Maine to North Dakota; it is a low-growing species parasitic on other plants, producing small flowers in leafy clusters. Each flower is colorfully marked, the upper lip being purple and the lower white with purple stripes and a yellow "eye".

Two of the commonest members of the Figwort Family are introduced Eurasian plants. Mullein (*Verbascum*) is a large genus of Old World plants, several species of which have become well established as American roadside weeds. They are tall with alternate, often basal, leaves and elongated terminal clusters of flowers with five-lobed corolla. Woolly Mullein is a densely hairy plant with a large basal cluster of yellowish-green leaves and pale yellow flowers. White Mullein is also a woolly species, with white or cream colored flowers. Moth Mullein has a loose cluster of larger flowers, white or yellow in color. Butter-and-Eggs—also known as Yellow Toadflax (*Linaria*)—has alternate narrow leaves and flowers in elongated clusters which also contain leafy bracts. The corolla is conspicuous because of its long spur which projects back from the flower; the upper two-lobed lip is light yellow and erect, while the lower three-lobed lip—also yellow—has an orange colored fold closing the throat of the flower. A native relative of this Eurasian species is Blue Toadflax with purple flowers, found in sandy places along the coastal plain to Nebraska and on the Pacific coast.

THE BIGNONIA FAMILY

There are about five hundred species of trees, shrubs and woody vines—rarely herbaceous plants—in the Bignonia Family (*Bignoniaceae*), most of them tropical in their range. The leaves are usually opposite or whorled, the flowers large and showy with a calyx of united sepals and a five-lobed, two-lipped corolla. The few native representatives of the family include Cross Vine, Trumpet Creeper, Catalpa and Desert Willow; the Jacaranda is an introduced tree common in the southern states.

Cross Vine or Trumpet Vine (*Anisostichus*) is a tendril-bearing vine with compound leaves each made up of two leaflets, and tubular flowers with a five-lobed margin. The flowers are orange-red on the outside, and yellow on the inside. This flowering vine is native to swamps and stream banks from Virginia to Louisiana and Illinois.

Trumpet Creeper (*Bignonia*) is another woody vine, but differs in having pinnately compound leaves and climbing by means of aerial rootlets. The ten species in the genus are mostly native to tropical America; our native representative is a yellow flowered climber found in woods from Florida to Texas and Iowa.

Catalpas are favorite street and lawn trees throughout most of the eastern states; the genus *Catalpa* includes five species which are native to North America and Japan,

all with large heart-shaped leaves and showy flower clusters. The Common Catalpa or Indian Bean is a small tree native to our southern states but widely naturalized from coast to coast ; it has white flowers, yellow striped within the throat and purple spotted, with two small upper lobes and three larger lower ones. The fruits are long bean-like pods containing hairy tufted seeds. Western Catalpa ranging from Illinois and Indiana to Mississippi and Louisiana, has larger flowers (often several inches in diameter) and grows to be a hundred feet tall. Chinese Catalpa, with small yellow flowers, striped with orange, is often planted as an ornamental tree.

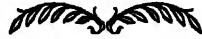
Associated with the Mesquite and Smoke Trees of dry river washes and gravelly canyons of the southwestern deserts is the shrubby Desert Willow (*Chilopsis*), a tree with narrow willow-like leaves and colorful pink flowers each with a wavy-edged lobed corolla.

Jacarandas (*Jacaranda*) are popular street trees in Florida, southern California and other warm portions of the United States. They are native to Brazil, with finely cut fern-like foliage consisting of twice pinnate compound leaves, often much like that of some of the Acacias. The flowers are blue or violet colored, in clusters ; the rim of the corolla is divided into five equal lobes.

THE OCOTILLO FAMILY

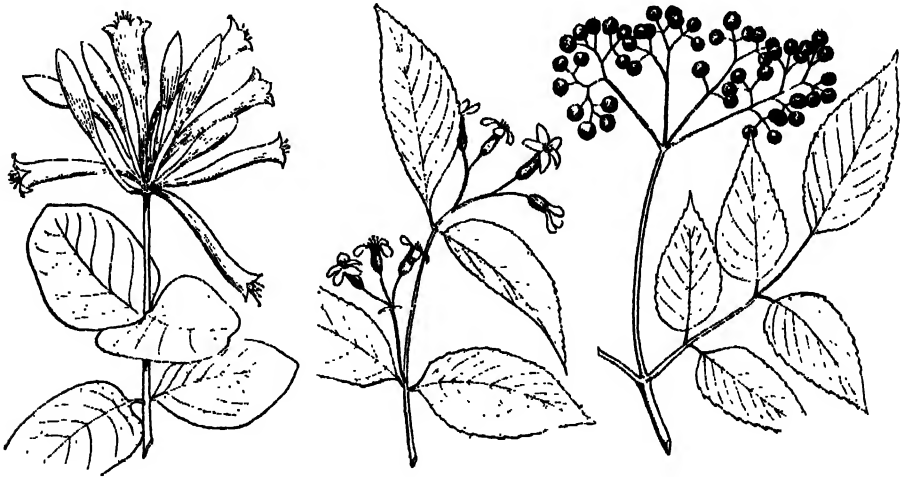
Among the distinctive American families of desert plants, the Ocotillo Family (*Fouquieriaceae*) with but the single member Ocotillo (*Fouquieria*) is one of the most bizarre. Inhabiting the gravelly and rocky slopes of our southwestern deserts and into Mexico, Ocotillo grows in clumps often twenty-five feet high, spreading out from a common base. The slender gray cane-like stems bear spines and short-lived small leaves. When in flower, Ocotillo is one of the memorable sights of the desert, each waving stem surmounted by a scarlet plume of many tubular flowers, each with a projecting mass of stamens.

The Honeysuckle and Gourd Families



THE HONEYSUCKLE FAMILY

THE sweet-scented Honeysuckle which covers so many porches and trellises with its honey-laden flowers is a familiar cultivated member of the Honeysuckle Family (*Caprifoliaceae*) which includes about three hundred species of shrubs, vines and a few herbaceous plants found throughout the Northern Hemisphere. Our native



CAPRIFOLIACEAE

Coral Honeysuckle, Bush Honeysuckle and Elderberry.

species are more numerous in the eastern than in the western states. The family is characterized by opposite leaves and terminal or axillary clusters of flowers with the calyx tube attached to the ovary, the calyx being made up of four or five minute lobes or sepals, and tubular or wheel-shaped corollas, somewhat two-lipped in some species. In addition to the Honeysuckles, the family includes the woody Elderberry, Hobblebush, Nannyberry, Maple-leaved Viburnum, Coral Berry and Snowberry; and the herbaceous Horse Gentian and Twinflower.

The true Honeysuckles (*Lonicera*) are native to North America and Asia, with a dozen or more common species in the eastern and central states. Coral or Trumpet

Honeysuckle is a woody vine with evergreen oval leaves and terminal clusters of numerous long slender trumpet-shaped flowers; each flower is bright scarlet, or sometimes yellow, in color. This brilliantly colored member of the genus grows in open woods and along riverbanks in most of the states east of the Rocky Mountains. Swamp Fly Honeysuckle, a shrub with downy elliptical leaves, grows to eight feet in height; the yellow flowers, decidedly two-lipped, appear in pairs in the axils of the leaves. This species is an inhabitant of bogs and swamps from New England to Pennsylvania and Michigan. Smooth-leaved or Mountain Honeysuckle is a twining or climbing plant of rocky woods and hillsides, ranging from New England to Georgia and Nebraska; the small yellowish-green flowers are tinged with purple. Of the western species, Chaparral Honeysuckle, found in California and Arizona, is a bushy shrub



CAPRIFOLIACEAE

Hobblebush, Twinflower and Snowberry.

flowering with interrupted spikes of yellow funnel-shaped blossoms. The cultivated Honeysuckles grown as shrubs or vines are various species introduced from China, Japan and the Himalayan region.

There are several Honeysuckles which belong to other genera. Bush Honeysuckle (*Dicrvillea*), a low shrub with small clusters of regular five-lobed flowers in the axils of the upper leaves, as well as terminal blossoms, thrives in dry, sandy or rocky woods of our northeastern states. The Fly Honeysuckle (*Xylosteon*), another shrub of rocky woods, grows in the same general area; its yellow flowers, with short and almost regular corolla, are produced in pairs. The Northern Swamp Honeysuckle (*Distegia*) frequents wooded stream margins from New England west to Colorado and the north Pacific coast; its yellow flowers, often tinged with scarlet, are in pairs, above leafy bracts.

Elder or Elderberry (*Sambucus*) is a genus of shrubs or small trees with pinnately compound leaves and pithy stems; small white flowers are borne in large flat-topped clusters. Each flower is urn-shaped with a spreading five-lobed corolla. The

juicy berry-like fruits are usually blue, purple or red in color. The common Elderberry of the eastern states grows in wet woods. Its purplish-black fruits are often made into a tart wine. The Red-berried Elder, producing clusters of red fruits, is found in damp rocky places from coast to coast.

Another shrubby genus of the Honeysuckle Family is *Viburnum*, which lacks the pithy stem of the Elder, and has larger deeply five-lobed white flowers in flat-topped clusters; the leaves are either pinnately or palmately veined. Maple-leaved *Viburnum*, found in rocky woods from New England to Georgia and Minnesota, has palmately lobed maple-like leaves and clusters of flowers all of uniform size. Hobblebush or Moosewood, a struggling shrub of the northeastern and north central states, with



CUCURBITACEAE

Mock Apple, Star Cucumber and Calabazilla.

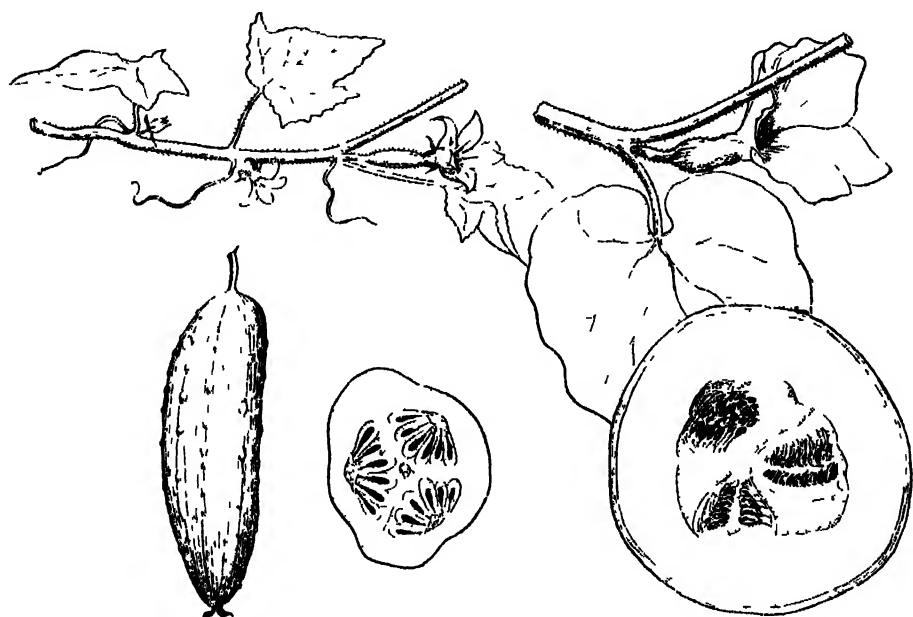
large ovate leaves, has showy clusters of flowers, the marginal ones sterile with greatly enlarged corollas; the fruits are orange-red in color. Nannyberry, which sometimes grows to a height of thirty feet, lacks the marginal sterile flowers found in Hobblebush and differs further in having blue-black berries; it grows in rich woods from New England westward to the Dakotas, south to Georgia.

Coral Berry or Buckrush (*Symphoricarpos*) is a low shrub with purplish branches, clusters of greenish-red flowers in the axils of the leaves, and red berries; this member of the family thrives along riverbanks in most of the eastern and central states. Snowberry, found in rocky woods from coast to coast in the more northern states, is a related species with white berries. The Waxberry of California and states adjacent to New Mexico, has pink flowers in small clusters, and white berries.

The two herbaceous members of the family are the wild flowers, Twinflower and Horse Gentian. Twinflower or Deer Vine (*Linnæa*) is a delicate, creeping plant of cold woods from New England to the north Pacific coast; the leaves are rounded and evergreen, and the unusually fragrant nodding flowers are borne in pairs at the tips

of erect stems. Each flower has a pink funnel-shaped corolla with a five-lobed margin. Horse Gentian or Feverwort (*Triosteum*) grows erect in thickets and on hillsides from New England to North Carolina and west to Kansas, the solitary flowers, borne in the leaf axils, are purplish-red and two-lipped.

Two related groups of plants, classified with the Honeysuckles in the Madder Order (*Rubiales*) are the Madder Family (*Rubiaceae*) already described in the chapter dealing with the beverage plants, and the relatively insignificant Teasel Family (*Dipsacaceae*). This latter includes a few hundred Old World species of herbaceous plants, many of them with prickly stems. The common Teasel (*Dipsacus*) is a Euro-



CUCURBITACEAE

Cucumber blossoms and fruit (*left*), Muskmelon blossom and fruit (*right*)

pean plant often found naturalized in fields and along roadsides in the United States, it is a coarse prickly plant with small blue and white flowers clustered in a cylindrical head, with spiny bracts projecting from among the flowers. *Scabiosa*, another European genus, is frequently cultivated in gardens and escape to become a roadside flower, the stems are smooth, and the blue, rose, yellow or white flowers are borne in showy heads, surrounded by herbaceous bracts.

THE GOURD FAMILY

Some families of plants are recognized by their unusual flowers, others by their habitats, in the case of the Gourd Family (*Cucurbitaceae*) the various members are known for their large and peculiar types of fruit, of which the pumpkin and the watermelon are familiar examples. The Gourd Family includes some seven hundred, mostly tropical, vines with tendrils and lobed leaves. The ovary of the trumpet-shaped flower

is attached to the lower part of the calyx, and with it produces the fleshy or dry peculiar berry with a thick rind, known botanically as a "pepo". Our only native species are the Mock Apple, Chilicothe, Star Cucumber and a few Gourds. There is a great number of cultivated forms, such as Cucumbers, Melons, Squash and Pumpkin.

Mock Apple or Wild Balsam Apple (*Echinocystis*) is a tall climber found along stream bank thickets from New England to Virginia, west to Texas and Colorado. The leaves are five- to seven-lobed and the small white flowers are borne in axillary clusters; each corolla consists of six spreading petals united at the base. Familiar to children of rural areas is its inflated berry of fibrous consistency, armed with spines. The ripening fruits often burst open so forcibly that they eject the large seeds several feet. The southern Californian species, Chilicothe, has ivy-like leaves, white flowers and spiny oblong fruits.

Star or Bur Cucumber (*Sicyos*) of eastern and central woodlands is a vine with angular lobed leaves and greenish-white flowers with five petals, united at their base. The clustered ovoid fruits are bristly, and contain a single large seed. This member of the Gourd Family grows rapidly, reaching a length of fifty feet—quite an achievement for an annual plant.

The Pumpkin genus (*Cucurbita*) includes only a few native species. Calabazilla, common in sandy places from California to Texas and Nebraska, is a common gourd-bearing vine with triangular leaves and yellow bell-shaped flowers. The fruit is a smooth round gourd, yellowish in color and marked with greenish stripes. There are several other southwestern representatives of the genus, whose gourd fruits are often used for decorative purposes. The garden Pumpkin is a prickly stemmed vine native to tropical America, known to have been cultivated by the aboriginal Indian tribes before the arrival of the Spanish explorers. This vine has the largest fruit of any member of the family, specimens weighing 150 pounds having been grown. Squash is another species of *Cucurbita*, also a native of tropical America.

Cucumber (*Cucumis*) originally came from the East Indies, while Muskmelons and Cantaloupes—also species of *Cucumis*—are native to Asia and were grown by the Egyptians and Romans. The Watermelon (*Citrullus*) is of African origin, where it was cultivated by native tribes long before it became known to the Egyptians; watermelons were grown in China as early as the tenth century.

CHAPTER XXXVIII

The Composites



ONE conspicuous tendency among the Dicots has been the crowding of flowers into clusters, thus increasing and concentrating the mass of attractive color or scent which lures insects and other pollinating animals to the flowers. This is particularly true of plants with flowers so small that they would be ineffective if scattered about among the leaves in attracting the attention of animals. In many cases, as in the Flowering Dogwood, Poinsettia, Bougainvillea and Calla Lilies, the clusters of small and inconspicuous flowers are surrounded by large brilliantly showy bracts which function as petals—for which they are often mistaken. The tendency towards flower clusters is well illustrated by the Carrot Family (Chapter 33) in which there is a compact umbel of small flowers, each on its own long stalk. The climax of evolution of efficient flower clusters, however, is found in the head composed of many small flowers (Daisy, Dandelion, Aster) ; this is typical of the group of Dicots known as *Compositae*. Such a composite flower head, often mistaken for a single flower, is in reality little more than an umbel with shortened individual flower stalks, thus bringing the individual flowers close together on the broadened top of the stem. At the same time the bracts which occur at the base of the flower stalks form an involucre beneath the whole head of flowers. This aggregate of small sympetalous flowers is therefore seated in an involucre which, because it is conspicuous and green, is often mistaken for a calyx. In some genera it is armed with hooked spines and attaches itself to animals, thus aiding in dispersal of the seed ; a particularly good example of this is seen in the Burdocks.

In the typical flower of a Composite, the calyx has lost its green leaf-like character and has become transformed in part into scales, bristles or downy projections which often serve most ingeniously for the dispersal of the seed. This is well illustrated by the spiny projections of the Tickseeds adapted for dispersal by animals, or the downy parachute of the Dandelion seed adapted for wind dispersal. The corolla is tubular, and has evolved along two different directions, resulting in division of labor within the flower head itself. In the center of the head the flowers are slender and tubular, forming a central disc of closely packed corollas ; these disc flowers are fertile and produce stamens and pistils. Along the margin the terminal part of the corollas has become flattened and asymmetrical, often broadly strap-shaped and resembling the individual petals of a simple flower. These ray flowers, as they are called, are

often mistaken for petals ; since their function is chiefly that of display, for attracting animals. They have given up some or all of the reproductive functions, being entirely sterile or lacking stamens.

"It is now easy to understand why the head of an aster, dahlia or marigold is commonly mistaken for a single flower and why the sunflower has received its name. The community of flowers that form the head have worked together to solve the same problems of attraction, protection and distribution that formerly confronted the indi-



CARDUACEAE

Ironweed, Boneset and Blazing Star.

vidual flower, and the solutions found have been of the same general character. In spite of differences in structure and origin, the green involucre of the sunflower head performs the same tasks as the green calyx of the hollyhock. It protects the young flowers in the bud and provides food for them as well as for the new plants wrapped up in the seeds. The border of pennant-like ray flowers serves to attract insects and to furnish a landing platform for them just as the corolla does for the single flower. The ovary of the latter sometimes takes over the task of distribution, as in the case of the bedstraws, and this is now and then true of the involucre, such as that of the burdock and cocklebur. The head itself is the result of the advantages to be gained from grouping, and, once the rule for composites, is then employed like the single flower of simpler families to produce greater attraction by means of various kinds of grouping." *

The *Compositae* represent the highest specialization of flower structure of all the Dicotyls, and comprise the largest group of flowering plants, variously estimated at from thirteen to twenty thousand species ; they are also the most widely distributed group of flowering plants. The reason for this is chiefly the double advantage of a superior type of flower structure, ensuring pollination, and an effective diversity of

seed dispersal methods. The Composites are generally grouped into three families, all closely related. Largest and perhaps most primitive of the group is the Thistle Family, with its flowers grouped in showy heads particularly adapted for insect pollination; these are made up either of disc flowers only, or of disc flowers and ray flowers. The Chicory Family is characterized by an absence of disc flowers, the entire head being made up of ray flowers. And the Ragweed Family has specialized in wind pollinated greenish flower heads, with staminate and pistillate flowers borne separately, in many cases lacking corollas.

There is a great number of familiar wild flowers among the Composites, many of



CARDUACEAE

Ageratum, Golden Aster and China Aster.

them abundantly represented in the late summer and autumn flora of the eastern states, and the most common of all the flowering plants in the West. Our native species are chiefly herbaceous or shrubby ones, but no trees. Although it is relatively easy to recognize a Composite, it is difficult to identify individual species; this, added to the size of the families, makes it impossible in a brief and untechnical account to do more than suggest some of the important members of this huge group. Economically, the Composites are surprisingly unimportant, out of all proportion to the number of species. The only food plants are Artichoke, Lettuce, Endive, Chicory and Dandelion. Their greatest importance lies in the number of representatives under cultivation as garden flowers, including such old favorites as Aster, Cosmos, Zinnia, Coreopsis, Marigold, Dahlia and Chrysanthemum.

THE THISTLE FAMILY

The Thistle Family (*Carduaceae*) includes about ten thousand species, mostly herbaceous plants and only a few shrubs, widely distributed throughout the world. Many of them are our worst weeds. The flower head may or may not have ray flowers in addition to the tubular disc flowers. The ray flowers, when present, are strap-shaped and petal-like, pistillate or sterile; the disc flowers develop fertile stamens, or both

stamens and pistils. For convenience this unwieldy family is subdivided into a dozen or more "tribes", each with definite botanical characteristics. The Boneset Tribe and Ironweed Tribe have only disc flowers, which are various colors but never yellow; the receptacle of the flower head is generally naked, lacking bristles or bracts. Other tribes usually with only disc flowers include the prickly Thistle Tribe and the whitish woolly Everlasting Tribe. The common Aster Tribe, Sunflower Tribe, Sneezeweed Tribe and Chrysanthemum Tribe usually have both ray flowers and disc flowers. Other tribes include the Marigolds and the Ragworts.

* * * *

The Ironweed Tribe is a small one, consisting of only two common genera found in



CARDUACEAE

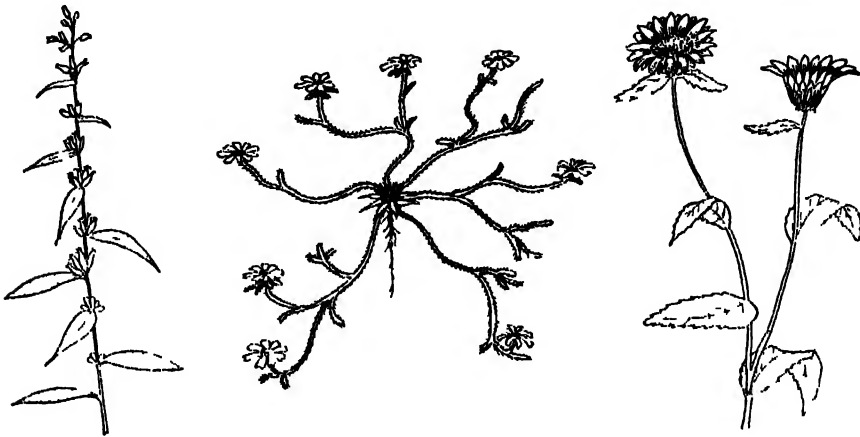
Seaside Aster, Calico Aster (*upper center*), Desert Aster (*lower center*), New England Aster (*right*).

our eastern and southern states. Ironweed (*Ironia*, named after William Vernon, an English botanist who studied American plants) is a coarse-stemmed plant growing to a height of nine feet, with narrow pointed leaves and terminal clusters of flower heads, each head made up of twenty to forty purple flowers with tubular five-lobed corollas; it grows in moist thickets and meadows from New England to Georgia and Mississippi. There are only a dozen native species, a small percentage of the five hundred which are best represented in South America. Elephant's Foot (*Elephantopus*) is a hairy plant with ovate leaves, found in dry thickets from New Jersey to Texas and Kansas; clustered flower heads are each made up of two to five lilac-col-

ored flowers with narrow corolla lobes. There are only two other native species and a dozen more in the tropics.

* * * *

The Boneset Tribe includes a larger assemblage of common wildflowers, such as Thoroughwort or Boneset, White Snakeroot, Mist Flower, False Boneset, Climbing Hempweed, Blazing Star, and the cultivated *Ageratum*. The Bonsets (*Eupatorium*) include five hundred species of the warmer and tropical regions, with some forty in our eastern and southern states. The scientific name is derived from Eupator Mithridates, who is said to have used the plant medicinally. Common Thoroughwort or Boneset is stout and hairy with opposite veiny leaves, united by their bases, the flower heads are grouped in dense flat-topped clusters, each head consisting of about



CARDUACEAE

Silverrod, Desert Star and Gum-plant

a dozen lead-white flowers with triangular lobed corollas. This species inhabits wet meadows throughout the eastern and central states. Purple Boneset or Joe-pye Weed also has coarse veiny leaves, but these are in whorls of three to six, several to a dozen flowers make up each head in the loose cluster. This member of the genus grows in moist places from New England to Florida and Texas. The species known as White Snakeroot, found in rich woods from the Atlantic coast to the central states, has ten to thirty white flowers in each head, when eaten, the leaves cause a sickness of cattle which is often transmitted through milk to man, and known as "milk sickness." Mist Flower, of stream banks and marshes from New Jersey to Florida, west to Texas, has a conical rather than the usual flat receptacle and blue or violet flowers. Another plant known as Thoroughwort (*Brickellia*, named after J. Brickell, early Georgia Botanist), found on hillsides and in canyons from Kansas and Nebraska to Wyoming and Arizona, has umbels of nodding white or pink flowers. There are a dozen other western species, many of them willow-like, others whitish and hairy shrubs of the deserts. False Boneset (*Kuhnia*) is a closely related plant with stout stem and alternate resin-dotted leaves, and heads of ten to twenty-five creamy white flowers, it

is found in woods and along stream banks from New Jersey to Florida, west to Indiana.

Climbing Hempweed (*Mikania*) is a vine with opposite triangular leaves and compound clusters of white or pink flower heads, each made up of four flowers; it inhabits swampy woods and meadows of our eastern and southern states. Blazing Star, also known as Button Snakeroot (*Laciniaria*) is one of about forty North American species, of which our native representatives are found chiefly in the central states. This genus of the Boneset Tribe has alternate narrow leaves and rose-purple flower heads in spikes or elongated clusters; it is found in dry sandy soil from Virginia to Florida, west to Indiana and Texas. *Ageratum* is a genus from tropical



CARDUACEAE

Daisy Fleabane, Pussytoes and Elecampane.

America, much like Boneset in floral characteristics; the commonly cultivated species is a native of Mexico with small blue or white flowers in tassel-like heads.

* * * *

The Aster Tribe is one of the largest in the family including as it does, in addition to the numerous species of Asters and Goldenrods, the Golden Asters, Fleabanes, Desert Star and Gum-plants; and the shrubby Rabbit Brush and Coyote Brush. The Asters and Goldenrods complement each other in producing the blue and gold which predominate in the eastern landscape in autumn, making a colorful contrast unequalled by other flowering plants.

The Asters (*Aster*) derive their name from the Greek work meaning "star" because of the radiate character of the flower heads. They are among the most familiar of our wild flowers, abundantly represented in the eastern and central states. Of two hundred and fifty mostly North American species, fifty are found in New York State alone, a hundred in the southeastern flora; the number of species decreases as one goes westward, with less than twenty on the Pacific coast. Asters are usually bushy herbaceous plants with alternate leaves. The flower heads, either solitary or in clusters, consist of a hemispherical or bell-shaped involucre covered with bracts, a mar-

ginal series of pistillate ray flowers—blue, purple, pink or white in color—and a central disc of flowers producing both stamens and pistils. The disc flowers are yellow and have tubular corollas with five short teeth; they often darken in color when mature to a purple or reddish-brown. The Large-leaved Aster, with stout angled stems and broad heart-shaped leaves, bears a loose cluster of flower heads whose ray flowers—usually about sixteen in number—are lavender-blue, this species grows in shaded places from New England west to Minnesota and south to North Carolina. The Red-stalked Aster is a plant of wet, marshy places over practically the same area,

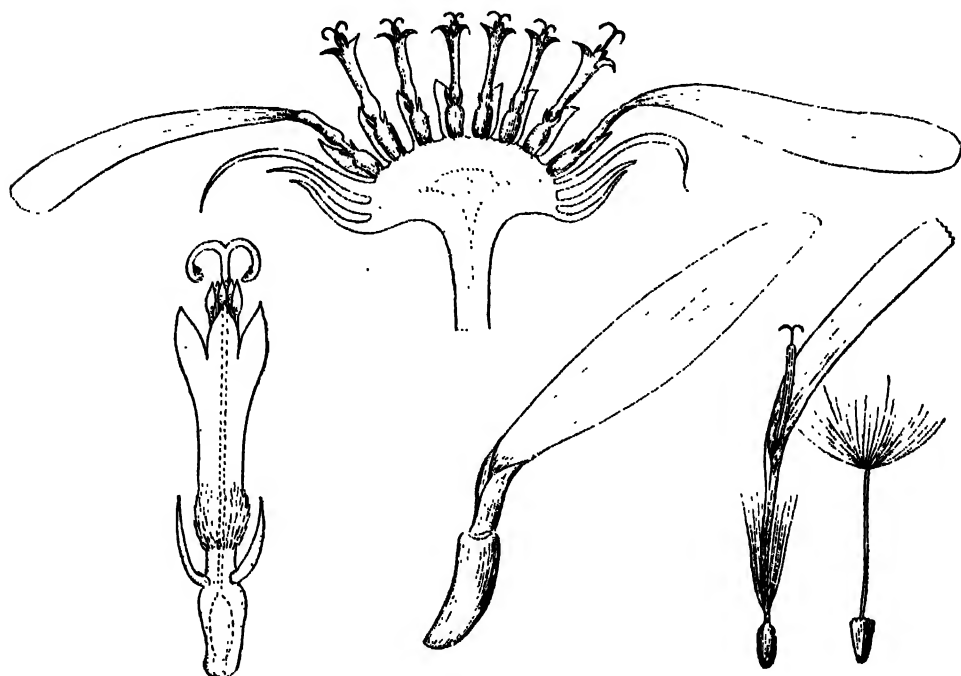


CARDUACEAE

Ox-eye Sunflower, tubercous roots of Giant Sunflower (*upper center*), Jerusalem Artichoke (*lower center*), Giant Sunflower (*right*)

its violet-purple ray flowers number twenty to forty, and the leaves are long and narrow. The Late Purple Aster is a flower of sunny fields of all our eastern and central states, recognized by its large deep-blue flower heads, each with twenty to thirty ray flowers, borne singly at the ends of short branches, and by its deeply heart-shaped clasping leaves. Growing in dry sandy soil near the seacoast from Massachusetts to Delaware is the Seaside Aster, a showy plant with stiff stems and several to many flower heads with bright violet-blue ray flowers. One of the most showy of the eastern wild flowers is the New England Aster, with flower heads often two inches in diameter, fringed with forty to fifty royal purple ray flowers and bearing a central disc of closely packed golden yellow disc flowers. This attractive member of the genus

grows in moist fields and woods from New England to Alabama, west to Kansas and Colorado. Of the white flowered species, the Calico Aster is a plant of open woods and fields of New England, ranging southward to Louisiana and westward to Texas; it has long narrow leaves and small flower heads (a half inch in diameter) with numerous short white ray flowers. The Mountain Aster, another white flowered species, has a zigzag stem, pointed oblong leaves and larger flower heads with fewer ray flowers; it is chiefly a northeastern species. Most of the western members of the *Aster* genus are blue or purple-flowered. Mexican Devilweed is a spiny, almost leafless, plant with small white flowers, found in low ground from California to Utah and Texas.



THE COMPOSITE FLOWER

Section view of flower head of Sunflower, showing bracts, two ray flowers and six disc flowers; (Lower left), section view of disc flower showing lobed and tubular corolla, projecting tip of pistil surrounded by stamens, degenerate sepals at base. (Lower center), a single ray flower of Sunflower. (Lower right), ray flower and fruit of Dandelion.

The delicately tinted Desert Aster is a species which has invaded the inhospitable sands of the California deserts, east to Utah; it has lavender-blue ray flowers fringing the large solitary flower heads.

In spite of the attractive flowers of many of our native species, Asters are cultivated only occasionally in American gardens; they make excellent border and rock garden plants, however. In Europe, many of our species have been cultivated for years. The Michaelmas Daisy is derived in part from the New England Aster. The frequently grown China Asters (*Callistephus*) are native to China and Japan. These

originally had two to four rows of blue, violet or white ray flowers, but breeders have created double-flowered varieties which are often fluffy-headed plants with red and purple flowers in addition to the original colors.

The Goldenrods (*Solidago*—a name derived from the Latin “solidare” meaning to make whole, because of reputed curative powers of the plants) include over a hundred, mostly North American, species especially abundant in the eastern states where their golden yellow color contributes to the glory of the autumn. Like the Asters they decrease in number of species as one moves westward, less than a dozen occurring on the Pacific coast. Goldenrods have alternate leaves, the basal ones frequently in a rosette, the flower heads, usually yellow, are much smaller than those of the Asters and are borne in bushy, often elongated and plume-like, clusters. In only



CARDUACEAE

Indian Cup, Tickseed and *Cercopsis*

a few species, such as the Flat-topped Goldenrods, the ray flowers are more numerous than the disc flowers. The Eastern Flat-topped Goldenrod, with narrow pointed leaves and bushy flat-topped clusters of stemless flower heads, grows in fields and along roadsides from New England to Florida west to Wyoming. The Western Flat-topped Goldenrod also has flattened clusters of yellow flower heads, it thrives in moist places from the Rocky Mountains to the Pacific coast. The most showy member of the genus is the Rock or Canada Goldenrod with its large waving plumes of countless small golden flower heads, arranged on one side of the spreading branches, it is common in thickets and on sunny hillsides from New England south to Virginia and west to the Dakotas. The Downy Goldenrod of the eastern states is typical of the more slender species with narrow spike-like clusters of golden yellow flowers, often intermingled with the leaves. The Pale Goldenrod or Silverrod usually has an unbranched erect stem bearing on its upper portion clusters of flower heads with white ray flowers and whitish bracts, it is found in dry and rocky soil from New England south to Georgia and west to Minnesota.

The Golden Aster (*Chrysopsis*) is a genus of cottony or hairy plants with alternate

leaves and showy flower heads, often in flat-topped clusters; each head consists of yellow ray and disc flowers. The Maryland Golden Aster has sessile ovate leaves and attractive flower heads an inch in diameter; its range is from New York to Florida and Louisiana. There are about a dozen other eastern and central species, a few western ones.

Desert Star (*Monoptilon*) is a flattened desert plant with spreading branched base and a central basal rosette of leaves; the daisy-like flowers have broad white or pink ray flowers and yellow disc flowers. This showy little desert flower blooms in the desert washes of California and Utah.

The Fleabanes (*Erigeron*—a name compounded from two Greek words meaning “early” and “old man”, in reference to the hoary grayness of some of the plants)



CARDUACEAE

Zinnia, Cosmos and Dahlia.

include over a hundred species, most common in America; unlike the majority of the genera of the Aster Tribe, they are as abundant on the west coast as in the eastern states. The flower heads, borne on saucer-shaped involucre, are solitary or in small clusters; the ray flowers are white, pink or purple, and the disc flowers yellow. The familiar Daisy Fleabane of fields and woods from coast to coast is a slender plant with downy stems and leaves, and flower heads an inch or less in diameter. The numerous small rose-purple ray flowers form a fringe around the central disc of yellow. Poor Robin's Plantain is a smaller plant with very few stem leaves and fewer (about fifty) ray flowers in each head; it is restricted to the states east of the Mississippi. The Seaside Daisy of the Pacific coast has solitary lilac or lavender ray flowers.

The Gum-plants or Sticky-heads (*Grindelia*) are coarse plants with sticky or resinous foliage and spiny-toothed leaves; the rather large heads have yellow ray and disc flowers. The few species are distributed through the central and western states.

There are two shrubby members of the Aster Tribe. Rabbit Brush (*Chrysotham-*

nus) is one of the few shrubs in the family, with a half dozen western species. They often have hairy or resinous foliage, and only disc flowers in the elongated heads of slender yellow flowers. One common species ranges from Kansas and Utah to Texas and New Mexico. Coyote Brush (*Baccharis*) is chiefly a western genus with resinous or sticky foliage, and flower heads made up of yellow disc flowers; it grows near the coast from California to Oregon. The Groundsel Tree is an eastern species, found on sea beaches and in salt marshes from New England to Florida and Texas; the flower



CARDUACEAE

Sneezeweed (upper left), Corn Chamomile (lower left), Desert Gold (upper center), Double and Single Marigolds (lower right).

heads bear greenish flowers, the staminate being tubular and the pistillate delicately thread-like.

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The Everlasting Tribe includes a few common plants, usually with only disc flowers in the flower head. In this group are the native wild flowers Marsh Fleabane, Arrowweed, Pussetoes, Everlasting, Cudweed and the naturalized Elecampane. The Marsh Fleabane (*Pluchea*) is an erect plant with alternate ovate leaves and branching clusters of flower heads made up of purplish disc flowers, found in various alkali habitats and salt marshes from coast to coast. Arrowweed is a related shrubby species of river bottoms from California to Texas, with a willow-like habit, silky leaves and purplish flowers. Pussetoes (*Antennaria*), woolly or hairy low-growing plants with basal tufts of leaves, include some fifty North and South American species, our native ones most abundant in the central states. The whitish flowers are seated in in-

volucres whose bracts terminate in petal-like tips. One common species thrives on dry soil from New England to Florida, west to Minnesota and Texas. Pearly Everlasting (*Anaphalis*) is a familiar silvery white plant, found from coast to coast in open fields; the pearly-white bracts of the involucre surround creamy-white small flowers, the outermost of several series with thread-like corollas, the central ones tubular; it is found in woods and thickets of our eastern states. Elecampane or Horse-heal (*Inula*) is a native of Europe which has made itself at home along our eastern



CARDUACEAE

Feverfew Chrysanthemum, White Daisy, Pompon Chrysanthemum (*upper right*), and Marguerite (*lower right*).

roadsides; its large flower heads, seated in an involucre whose outer bracts are leaf-like, consist of many narrow yellow ray flowers and dingy brown disc flowers. Several North Asiatic species are frequently cultivated as garden flowers.

* * * *

There are many familiar wild flowers as well as garden plants in the Sunflower Tribe which includes the various Sunflowers, Balsam Root, Leaf-cups, Compass Plant, Indian Cup, Ox-eye Sunflower, Black-eyed Susan and other Coneflowers, Zinnias, Tickseeds, Beggarticks, Tarweeds, and the cultivated Cosmos and Dahlia.

Sunflowers (*Helianthus*—the Greek equivalent of sunflower) are coarse, often tall, plants with showy flower heads whose conspicuous yellow ray flowers are sterile, the yellowish or purplish-brown disc flowers alone producing stamens and pistils. Of about a hundred American species, about forty occur in the eastern and southern

states, half that number in the prairie region and about half a dozen in the western states. The Common Sunflower, which under cultivation reaches a height of twelve feet and produces huge flower heads a foot or more in diameter, grows wild from Minnesota and Texas west to the Pacific coast. The flower heads to a certain extent change their direction from east to west with the sun. This is a surprisingly valuable species, its leaves being a fodder, the flowers yielding a yellow dye, and the seeds furnishing an oil and being a food for animals and man. In Russia the plants are grown for the seeds which are sold along the streets and eaten raw. Sunflowers are also cultivated in India, Turkey and Egypt. In swamps along the seacoast from Long Island to Texas grows the Swamp Sunflower, a species with narrow grass-like leaves



CARDUACEAE

Arnica, Golden Ragwort and Indian Plantain.

and flower heads several inches in diameter, each with a dozen or more yellow ray flowers and purplish disc flowers. Likewise dwelling in swampy habitats in the same area is the Giant Wild Sunflower, whose stiff hairy stems form a bushy growth ten or twelve feet in height, producing long-stemmed flower heads each with ten or twenty conspicuous yellow ray flowers and a yellowish-brown disc. The Woodland Sunflower is a more slender plant, rarely more than six feet high, of dry woods and roadsides of the eastern states, with flower heads of the usual size but on shorter stems. The Jerusalem Artichoke is a species of our west central states, often cultivated for its white tuberous rootstock which is fed to livestock; it was used by the Indians, and is considered a tasty salad plant in some localities. Another member of the Sunflower Tribe with an edible root is Balsam Root (*Balsamorhiza*), a low-growing plant with basal heart-shaped leaves, found on hillsides from South Dakota and Colorado westward; the broad yellow ray flowers surround a disc made up of chaffy bracts as well as tubular flowers.

Ox-eye or False Sunflower (*Heliopsis*), found from New England to Florida



Goldenrods (*Solidago*) form plumes of gold in the eastern fields; they decrease in number of species as one travels westward from the Atlantic coast. Mt. Desert Island, Maine.

(*Echinacea*) of open woods and fields from Pennsylvania and Louisiana west to Iowa has purple or rose-colored ray flowers

The Zinnias (*Zinnia*) include about twenty mostly Mexican and tropical American species, one of which ventures across the border into the Texas-Colorado region. This is a perennial with yellow ray flowers, which turn whitish with age, and brick red disc flowers. The common garden Zinnia is descended from a Mexican species with reflexed ray flowers, originally purple or lilac but changed by breeding to almost every color except blue and green, the disc flowers, which are absent in the double varieties, are yellow or orange.

The Tickseeds (*Coreopsis*, Greek word meaning 'bug-like' in reference to the appearance of the fruits of some species) have flower heads borne on long stalks and



AMBROSIACEAE

Poverty Weed, Western Ragweed and Cocklebur

involucres with colored bracts—usually orange or brown. The tips of the ray flowers are often notched or lobed and are a showy yellow or varicolor, the disc flowers are dark yellow or brown. Over two dozen species are native to the southeastern states, a few ranging into the northeastern and far western regions. The Lance-leaved Tickseed found from New England and Florida, west to Michigan, has opposite elliptical leaves and heads—often two inches in diameter—with six to ten bright yellow wedge-shaped ray flowers, notched at the apex. The Rose Tickseed is a slender wiry plant found in swamps along the coast from Massachusetts to Georgia, the small flower heads consist of four to eight pink or purple ray flowers, three-lobed at the apex or entire. Of the western species some are characteristic of the seacoasts, others of the deserts. The common Garden *Coreopsis* is derived from a midwestern species with lobed and wedge-shaped ray flowers, colored yellow with a dark purple base, dark purple disc flowers and involucre.

The Beggarticks (*Bidens*) are much like the Tickseeds except for their generally smaller flower heads and the character of the pappus. In the Beggarticks the pappus forms two to four rigid barbed spines which attach themselves to animals and thus



Pearly Everlasting (*Anaphalis margaritacea*) is a silvery white plant of open sunny fields from coast to coast. Brooksville, Maine.

act as means of dispersal for the fruits to which these spines are attached. Many a hiker through the autumn wood has had to spend hours picking the tenacious "ticks" from his clothing, not realizing that he is aiding the plants in their efficient means of seed dispersal. Most of the species, of which there are about twenty, are found in the central states, decreasing in number eastward and with but a few on the Pacific coast. A common Beggartick of eastern swamplands from New England to North Carolina, is the Nodding Beggartick or Bur Marigold whose numerous short-stalked nodding heads are less than an inch in diameter, with six to ten short yellow ray flowers and a yellowish-brown disc. Another Bur Marigold, also of swampy habitats,



CHICORIACEAE

Orange Hawkweed, Desert Dandelion and Rattlesnake Weed

has a transcontinental range, its erect flower heads have a neatly spherical involucre.

The Tarweeds (*Madia*) are strongly scented western plants with sticky foliage, whose yellow flower heads open only in the evening, close in the morning. A common species found from California to Oregon has ten to fifteen broad yellow ray flowers, others have less conspicuous heads.

One of the popular showy garden flowers of the Sunflower Tribe is *Cosmos*, the name being the Greek term for an ornamental or beautiful thing, the genus is tropical American and Mexican in its range. They are for the most tall bushy plants with pinnately subdivided leaves and large heads with white, crimson, rose or purple ray flowers possessing the same toothed or lobed apex as in *Coreopsis*, and yellow disc flowers. The common garden variety with white, pink or crimson ray flowers is a Mexican importation, as are the varieties with yellow and dark red rays and yellow or red disc flowers.



Black-eyed Susan (*Rudbeckia hirta*) is a plant of the open plains which has become well established throughout the eastern states. Brooksville, Maine.

fertile disc flowers, purple in color. The Perennial *Gaillardia* of our gardens is a cultivated form of a species found from Kansas to Oregon, whose yellow ray flowers are marked with purple bases. A common annual *Gaillardia* is a variety of a plant native to the Louisiana-Arizona region.

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Most of the Marigold Tribe are plants with ray flowers as well as disc flowers, they are often strongly and unpleasantly aromatic with glandular and delicately subdivided leaves. In this tribe we find the native Fetid Marigold and Lemon Scent, and the various cultivated Marigolds.



CICORIACEAE

Salsify, Chicory, Prickly Lettuce (upper right) and Garden Lettuce (lower right)

Fetid Marigold (*Boerha*) is a plant of prairies and roadsides, found from Ohio and Louisiana to Arizona and Montana, the fern-like leaves are divided into deeply cut segments and the flower heads bear yellow or orange ray flowers. Lemon Scent (*Pectis*), of sandy hillsides in the west central states, has narrow entire leaves with spiny bases and small heads of reddish-tinged yellow ray flowers and yellow disc flowers.

The garden Marigolds (*Tagetes*) are a genus of tropical American plants, some of which range across our southwestern border. The leaves are pinnately subdivided into narrow segments and are strongly scented. The involucre of the flower head forms a cup of united bracts. The "French" Marigold is a hardy garden annual with



Yarrow (*Achillea Millefolium*) is a naturalized European species which has become a weed in our eastern fields; the subdivided leaves are often mistaken for those of a fern. Hamilton, New York.

Tansy (*Tanacetum*) is a strongly and pleasantly scented plant, naturalized from Europe, with pinnately divided and fern-like leaves and a flat-topped cluster of small button-like heads whose yellow ray flowers hardly extend beyond the yellow disc.

Typical members of the prairie flora are the various species of Sagebrush (*Artemisia*), somewhat shrubby plants with a bitter, aromatic, penetrating scent associated with the "wide open spaces" of the west. There are over two hundred species native to North and South America, with thirty common members in the central states, half that number on the Pacific coast and relatively few east of the Mississippi. The small heads, erect or nodding, are yellow or purple in color; the gray-green leaves are entire or pinnately lobed. Sagebrushes are wind-pollinated members of the Thistle Family, and are often the cause of hay fever. A common species, with silvery-gray stems, wedge-shaped leaves and yellowish-brown flowers, inhabits the region from Colorado and Nebraska to the Pacific coast. A herbaceous species, Absinthie Wormwood, furnishes the intoxicant of the famous French beverage, absinthie.

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The Ragwort Tribe includes relatively few common species; among these are Coltsfoot, Indian Plantain, Ragwort and Arnica.

Coltsfoot (*Tussilago*) is a European plant naturalized throughout our eastern states, whose rounded and heart-shaped leaves, whitish hairy on the undersurface, appear after the flowers. The yellow flower heads are borne singly at the top of a scaly flowering stalk.

The Indian Plantains (*Mesadenia*) have strongly-ribbed leaves and clusters of small heads with grayish- or purplish-white disc flowers, no ray flowers; they grow in the woods from New England to Florida and westward to the plains.

Ragwort (*Senecio*), also known as Groundsel, forms a large genus, with two dozen species ranging through the prairie states, fewer in the far east and west; the ray flowers and disc flowers are both yellow, the former sometimes being absent. Golden Ragwort is a slender, smooth stemmed plant with ovate basal leaves and deeply lobed stem leaves, and with numerous bright yellow flower heads with eight to twelve ray flowers; it grows in wet habitats from New England to Florida and Texas.

Arnica (*Arnica*), found in wooded locations from South Dakota to the Pacific coast, has heart-shaped leaves and yellow ray and disc flowers; there are a half dozen species of the plains region, with a few on the Pacific coast. Medicinal preparations for the treatment of wounds and bruises are sometimes made from this plant.

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The Thistle Tribe is a distinctive one, since its members usually have prickly or spiny foliage and spiny involucre; the flower heads consist of tubular disc flowers only. There is a plume-like pappus which aids in wind dispersal of the seeds, which are familiar sights in autumn as they are carried about by the wind. Burdock, Thistle, Basket Flower, Dusty Miller, and Bachelor's Button are common representatives of this tribe. The Artichoke is an edible member.

Burdock (*Arctium*), naturalized from Europe, is a coarse bushy plant with heart-shaped leaves, whitish on the under side; the small purple disc flowers are grouped in a spherical involucre armed with viciously hooked bracts.



The spherical flower clusters of Burdock (*Arctium*) are armed with viciously hooked bracts, to facilitate animal dispersal of the fruits. Hamilton, New York.

The Thistle (*Cirsium*) includes several hundred widely distributed species with spiny leaves, most of them European but some native to our central and western states, all are obnoxious weeds, spreading rapidly by means of their silky-haired seeds. The Swamp Thistle, found in swampy soil from New England to Florida and Texas, has pinnately lobed leaves and solitary or several heads of purple flowers, with involucre lacking the barbed spines. The Canada Thistle is a European species naturalized from coast to coast, with similarly lobed leaves and purple or white flowers. The common Bull Thistle, also introduced from Europe, has spiny-tipped bracts on the involucre of the head, which bears rose-purple flowers.

Corn Flower or Bachelor's Button (*Centaurea*), with some five hundred species found in Europe, Asia and North Africa, is represented in the United States by a single species. The plants often have a prickly involucre, with showy purple, blue, pink or yellow disc flowers. Our native Basket Flower has a smooth involucre and rose or flesh-colored flowers with narrow fringe-like lobes often an inch in length, it ranges from Missouri and Louisiana to Kansas and Arizona. Dusty Miller is a low growing whitish woolly plant from the Mediterranean region, often used as a bedding plant in gardens, the prickly involucre is topped by purple flowers. The commonly cultivated Bachelor's Button—also known as Ragged Sailor—native to southeastern Europe, has long-stemmed flower heads with blue, pink or white flowers. The marginal corollas are often funnel-shaped with narrow lobes.

The only edible member of the Thistle Tribe is the Globe Artichoke (*Cynara*) which looks much like a large thistle, a native of North Africa and the Mediterranean region, its cultivation in England did not begin until the middle of the sixteenth century. It is grown as a crop plant in California, near the seacoast, the product is used locally and shipped to eastern markets. Large woolly leaves form a basal rosette from which the flower stalk rises, the edible portion of the Artichoke is the large globular involucre of the flower, with its thick succulent bracts.

THE RAGWEED FAMILY

The Ragweed Family (*Ambrosiaceae*) includes less than a hundred, mostly American, species of coarse herbaceous and shrubby plants, some of them the worst offenders in causing hay fever. The flowers are in inconspicuous heads, the bracts of the pistillate head sometimes forming a spiny bur. Staminate flowers have tubular lobed corollas while the pistillate flowers often have none at all. The family, by comparison with the Thistles, is of insignificant size and importance. It includes the Marsh Elder, Poverty Weed, the Ragweeds and Cocklebur.

Marsh Elder (*Iva*) is a shrubby plant of salt marshes from Virginia to Texas, growing to a height of nine feet, the flower heads, in the axils of leaf-like bracts, contain both pistillate and staminate flowers. Poverty Weed is a species of alkali flats from Oklahoma to the Pacific coast, with axillary nodding flower heads.

Ragweeds (*Ambrosia*) have subdivided leaves and inconspicuous greenish flowers, the staminate heads nodding in terminal spikes, the single pistillate flowers in globular involucre. There are less than a dozen eastern and central species, several western ones.

Cocklebur (*Xanthium*) is a coarse annual with the staminate heads in terminal



Thistle (*Cirsium*) seeds are buoyed up by silky hairs, as an aid to dispersal by wind Penobscot Bay, Maine

spikes; the pistillate involucre are closed and beaked, and armed with hooked spines. There are less than a dozen eastern and central species.

THE CHICORY FAMILY

In the Chicory Family (*Cicoriaceae*) we find an absence of disc flowers in the head, the ray flowers having an upper strap-shaped prolongation which is usually five-lobed. Many of the species have a bitter or milky sap. The leaves are mostly alternate, sometimes all basal. The involucre of the flower head is made up of one to several series of bracts, sometimes with a series of smaller additional bracts beneath. In this family we find the Common Dandelion, Desert Dandelion, Chicory, Salsify, Rattlesnake Root, Hawkweed, Lettuce and Endive.

The Common Dandelion (*Taraxacum*) is a European immigrant which, in spite of its attractive flower heads, has made itself one of the most thoroughly despised weeds throughout most of the United States. It has a basal rosette of pinnately lobed leaves, and milky-juiced stalks which bear heads of orange-yellow flowers; the seeds are borne aloft by the silky-haired pappus. Dandelion roots are used in Europe as a medicine and coffee substitute, the leaves frequently for "greens" and in making wine. The Desert Dandelion (*Malacothrix*) has a similar basal tuft of leaves, woolly and pinnately divided; the pale yellow flower heads are fragrant, and have square tipped and toothed margins. This is one of a dozen species found in the western states. •

Chicory (*Cichorium*) is an Old World genus with toothed or pinnately lobed leaves and sky-blue or white heads made up of broad-lipped ray flowers with toothed margins. A common species is found naturalized from coast to coast. The roasted roots are used as an adulterant and substitute for coffee. Endive is another species of *Cichorium*, native to India, brought to the Mediterranean in the time of the Egyptians and Greeks; the plant is grown for the young basal leaves, which are usually curled and blanched, and used as a salad plant.

Salsify or Oyster Plant (*Tragopogon*) is a native of southern Europe with long narrow grass-like leaves and dull purple flower heads; the plant is grown for the gray milky tap roots which are said to have the flavor of oysters.

Rattlesnake Root (*Nabalus*) is a small genus of our eastern and central states with small clustered and usually nodding heads of cream-colored or pale purple flowers.

The Hawkweeds (*Hieracium*) constitute a large genus of three hundred species; but only a dozen or less are common in the eastern and central states, and even fewer in the far west. Most of the leaves are in a basal tuft from which arises the erect flowering stalk with its solitary or few orange or yellow flower heads. Devil's Paintbrush or Orange Hawkweed, naturalized from Europe, is a hairy plant with orange heads borne atop a leafless hairy stem, the individual flowers with five-toothed strap-shaped corollas. King Devil, also a European immigrant, has somewhat smooth slender stems and bright yellow flower heads. The Rough Hawkweed is a native eastern and central species which grows to be a bushy plant, with reddish-haired stems and leaves, and clusters of yellow flowers. Rattlesnake Weed or Poor Robin's Plantain is a low-growing plant with ovate basal leaves marked with purple veins, and slender flowering stems bearing clusters of yellow flower heads.

A familiar edible member of the Composite group is Lettuce (*Lactuca*), whose



The familiar Dandelion (*Taraxacum*) is a representative of the Chicory Family which is characterized by ray flowers only in the flower heads
Hamilton, New York

seventy-five species are widely distributed throughout the Northern Hemisphere. A native Wild Lettuce or Horseweed, with yellow flower heads, grows from New England to Louisiana. Garden Lettuce is considered by some to have been developed from the Prickly Lettuce which is found in the Mediterranean region. Lettuce as a food is mentioned by the early Greek writers, and is known to have been used in China in the fifth century. When grown as head Lettuce, the flowering stalk is not permitted to develop. Lettuce is grown as a crop chiefly in California; and to a lesser extent in Arizona, New York and Colorado. The European Prickly Lettuce, found naturalized in the eastern states, has pinnately lobed leaves which tend to radiate in four directions; hence it also is known as Compass Plant.



SPERMATOPHYTA: ANGIOSPERM MONOCOTS

The FRUIT-SEED PLANTS—*Angiosperms*—also include the group of the Monocots. These usually differ from the Dicots by having floral parts in threes or sixes, and parallel-veined leaves as typified by the Grasses, Lilies or Palms; the stems do not have a growing ring beneath the bark, hence cannot grow indefinitely in thickness and rarely become woody trees. In contrast with the Conifers and Dicots, few of the Monocot species are trees; exceptions are Bamboo, Palms and Joshua Trees. The majority are herbaceous plants, some being exceptionally well adapted for colonizing areas with slight rainfall; these are the Grasses which form the prairies and steppes of the world. The insect-pollinated members of the Monocots reach their climax in the showy flowers of the Orchids. Taken as a group, the Monocots are less diversified than the Dicots. Many of them form the dominant features of tropical vegetation.

CHAPTER XXXIX

The Grasses and Cereals

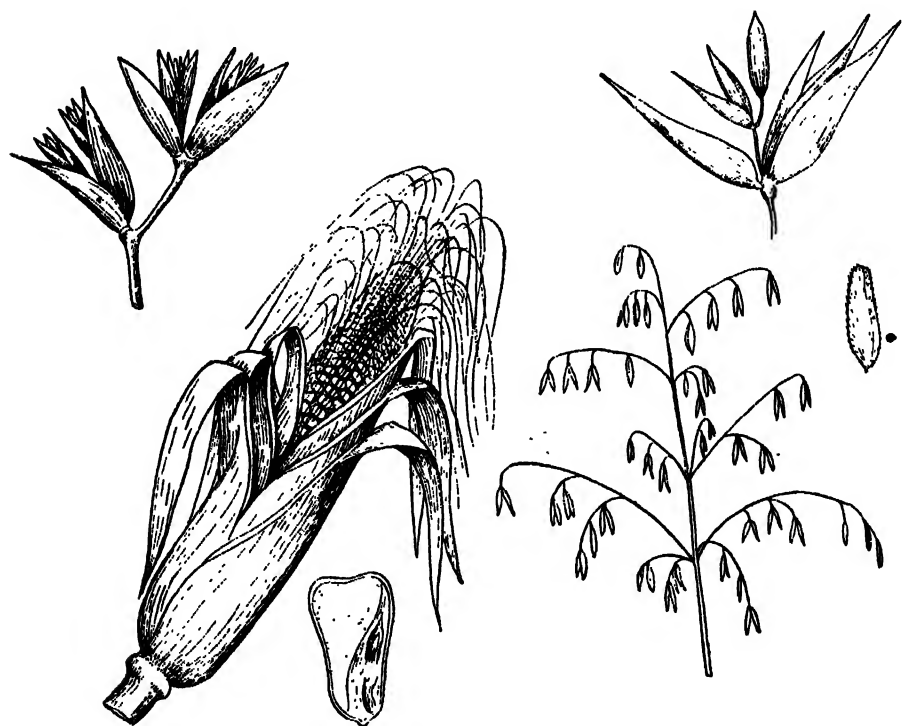


IN THE great Dicot group of the *Compositae* we saw the tendency to group many small flowers into a single head brought to perfection, each head being large and showy, often fragrant, for the purpose of insect pollination. In the Grasses and Sedges (*Glumiflorae*), the largest order of the Monocots, the same tendency to reduce the size of the individual flowers and to group them in clusters is evident; but because they are adapted for wind pollination they are not brightly colored and lack the perianth typical of the Composites. In fact it surprises many people that grasses have flowers, since these are so small they are often unnoticed. Each flower is borne in a spikelet, frequently with stiff projecting hairs; the spikelets are grouped on an axis to form either a compact spike known as the head or ear, or an open branching cluster. There are two families in the *Glumiflorae*, the Grasses and the Sedges. The Grass Family, economically the most important, includes plants of medium moist and dry habitats; their leaves occur in two ranks and the cylindrical stems are usually hollow except at the nodes. The Sedge Family, on the other hand, is partial to wet and swampy habitats, has leaves arranged in three ranks, and solid stems which are angular, flattened or cylindrical.

THE GRASS FAMILY

The Grass Family (*Poaceae*), including seven thousand widely distributed species, is one of the most important families of food plants, many of them having been cultivated for over five thousand years. Grasses as a group hardly need description, the narrow parallel-veined leaves of familiar lawn and crop species being fairly typical of the whole family. They are annuals or perennials with fibrous roots, often with underground stems which extend horizontally and give off new tufts of leaves, in this way forming a compact sod ideal for lawns and effective in checking erosion of loose soil. Under favorable conditions grasses seldom grow singly, but instead form extensive communities which are characteristic features of the landscape of our prairies, the steppes of Russia, and the pampas of South America. Most of the grasses are low-growing herbaceous plants, though some (Maize, Sugar Cane) grow ten to twelve feet in height, and a few (Bamboo) grow to be trees. Grass flowers consist of stamens and pistils without petals and sepals, and are surrounded by various kinds of bracts, some of which bear appendages prolonged beyond the spikelet as awns

or beards. There are usually three stamens and a single pistil with a branched and feathery tip for the efficient capture of the pollen grains. Many species are self-pollinated, others depend upon wind to bring pollen from plant to plant. The fruit formed after pollination is a one-seeded grain, the ovary forming a dry fruit coat which adheres closely to the seed as a thin husk. The seed is oval, cylindrical or tooth-shaped; the tiny embryo is tucked away in one end while most of the seed is filled with stored food (endosperm). The grains are usually yellow, brown, red or purple in color. The fruits of the cereal grains have been prized foods of mankind since earliest



POACEAE

Indian Corn—spikelets from tassel (staminate flowers) and cob with pistillate flowers (*left*); Oats—spikelet (*upper right*) and tassel of spikelets (*lower right*) with fruit (oat grain).

times, furnishing the "staff of life" for most races of people. By careful breeding and selection through the years, grains have been made larger and their food content more abundant to an extent which can be realized when we compare corn, wheat or oat kernels with the almost microscopic grains of most grasses. The cereal grasses can be grown in a wide variety of soils, under great diversity of climatic conditions; this has been a factor in making them universally valuable as food crops. In addition the cereal grains are, as near as is possible, a perfect food containing all the essential nutrients; and because they are dry fruits, they can be stored and shipped with ease and success.

The Grass Family is a confusing one for the amateur ; and, as with the Composites, no attempt will be made to so completely describe the various species that they can be identified. The complex group is subdivided into tribes, and typical representatives of the more important tribes will be considered. These include the Maize Tribe, with Maize, Teosinte and Gama Grass ; the Oats Tribe, with Oats, Velvet Grass, False Oats and Oat Grass ; the Rice Tribe ; the Barley Tribe, with Barley, Wheat, Rye, Darnell and Quack Grass ; the Millet Tribe, with the various Millets, Witch Grass, Crab Grass, Bur Grass and Foxtail Grass ; the Sugar Cane Tribe, with Sugar Cane, Sorghum and Beard Grass ; various lawn and forage grasses such as



POACEAE

Wheat plant (*right*), with spikelet and grain (*upper center*) ; Rice (*lower center*) and Wild Rice ; Velvet Grass (*lower right*).

Sweet Grass, Wire Grass, Porcupine Grass, Timothy, Bent, Bluegrass, Buffalo Grass and Marsh Grass ; and the Bamboo Tribe.

Maize or Corn (*Zea*) differs from most of the grasses in having separate staminate and pistillate flowers. Staminate flowers are clustered to form the plume-like tassel at the top of the corn plant, while the pistillate flowers are grouped on an axis (the cob) lower down on the stalk. The entire pistillate axis is enclosed by leafy husks, and thread-like projections from each pistil (the silk) extend beyond the husk to catch the pollen. Corn stems are solid, being composed of pithy material in which the

vascular strands are imbedded. Ordinarily fibrous roots could not support the ten to fifteen feet of leafy stalk characteristic of the average corn plant ; but special prop roots grow out of the base of the stem, arch over and act as buttress supports. Maize is a subtropical and tropical American plant, whose wild ancestors are now unknown but are considered closely related to Teosinte (*Euchlaena*), a Maize-like plant native of Mexico. The pistillate "ear" of Teosinte, however, is not on a cob ; each individual kernel has its own covering, and is arranged on the side of the axis diagonally opposite from the kernel above and below it. Maize was the primitive cereal grain of the Western Hemisphere, cultivated by the Mayas a thousand years ago and by various



POACEAE

Timothy (*left*), Barley spikelet, Quack Grass, Darnell Grass and Witch Grass (*right*).

Indian tribes of Central and South America before that date. There is also evidence that it was grown in our Southwest several thousand years ago. Today it is the chief feed grain of the American livestock region known as the Corn Belt, which extends from Ohio to Nebraska, with Wisconsin and Minnesota as the northern limits. Of the many varieties grown today, Dent Corn is most widely planted ; its kernels have a soft and starchy endosperm. A related variety known as Flint Corn is an ancient type that was cultivated by the Indians of the Southwest. The kernels of Sweet Corn are shriveled, with a translucent coat. Pop Corn is a variety with a tough covering which holds in the moisture when the grain is heated until finally the steam causes an explosion, turning the grain inside out. Maize has a wide variety of uses. It is canned,

made into cornmeal and breakfast foods, used as a food for stock ; it is also a source of oils, starch, syrups, alcohol and gums. The pith of the stalk is made into explosives and the stalks themselves are manufactured into a coarse grade of paper. Even the cobs are utilized in making pipes and charcoal. The embryo of the grain is rich in oil, which is extracted for use in cooking, and made into soaps and paints. Corn starch, an important product of the corn industry, is made by steeping the kernels in warm water and sulphur dioxide, then breaking up the softened grains to separate the embryos from the endosperm ; the solution with starch and protein grains in suspension is



POACEAE

Crab Grass, Bur Grass, Foxtail Grass and Beard Grass.

passed over an inclined table so that the proteins float off while the starch grains settle to the bottom. From the starch is manufactured dextrins and the British gums, used on envelopes and postage stamps, and in the textile industries. Starch is also used as a source of alcohol, a ton of corn yielding about ninety gallons of alcohol. By hydrolyzing the starch, various corn and glucose syrups are made.

Gama Grass or Sesame Grass (*Tripsacum*) is a native member of the Maize Tribe ; it is a tall grass, six to eight feet in height, with broad leaf blades and an elongated flowering spike of which the upper part consists of staminate spikelets, the lower portion, pistillate. Gama Grass grows in swamps and along pond margins, from Nebraska to Florida and Texas.

Oats (*Avena*), native to eastern Russia, was cultivated by the barbarian inhabi-

tants of Europe before the time of Christ, but was not grown by the Romans and Greeks. It became more widely known after the Middle Ages. Wild varieties today exist in Persia, Arabia and northern Africa. The spikelets of Oats are grouped in an open cluster, usually spreading outwards in all directions. Large bracts completely cover the three flowers in each spikelet, forming a closely adhering hull. Oats are grown chiefly as a stock fodder, only a small percentage being made into breakfast cereals. Being one of the cereal grains which thrives in a cool moist climate, it is grown extensively in Scotland, the Scandinavian countries, Canada, Washington, Montana, Minnesota and Maine. Oats constitute the chief cereal crop of Great Britain, growing well on peaty soils.

There are a few other members of the Oats Tribe worthy of mention. Wild Oat Grass (*Danthonia*) is a low plant of hillsides and woods, with sparsely flowered clusters made up of large spikelets, armed with stout awns. A few species are common in our central and eastern states. Velvet Grass (*Holcus*), naturalized from Europe, grows in moist meadows; its narrow clusters of purplish spikelets have short hooked awns above each flower. False Oats (*Trisetum*) is an Arctic and temperate genus with several species native from coast to coast in our northern tier of states; they are low tufted grasses with a spike of flowers, each set amid awned bracts.

Rice (*Oryza*), a swamp-dwelling grass of the Old World tropics, was cultivated as a crop in eastern and southern Asia at least five thousand years ago. It is the chief article of food at every meal for millions of people in China and India, rice being to the Orient what wheat is to the Occident. After the sixteenth century its use spread to the rest of the world. Since water hastens germination of rice, it is usually grown on delta and alluvial grounds capable of being flooded. Rice is a typical grass with hollow stems, growing to a height of five feet and bearing one-flowered spikelets in a narrow branching cluster. The bracts adhere closely to the grain, which together form a fruit known as "paddy". Before being milled, rice has a brown fibrous covering and outer layers of protein food material; milling removes these and leaves a white grain which is further scoured and polished between pieces of pigskin and finally coated with glucose and talc before being marketed. In addition to being used as a staple food, rice plants furnish a Japanese beer known as "saké"; the straw is used as a stock food and in making paper, hats, and strawboard. Our native Wild Rice (*Zizania*) is a related genus found in freshwater and brackish marshes from New England to Texas and North Dakota; it is an annual with tall stout succulent stems which reach a height of nine feet, and large terminal clusters of spikelets.

Wheat (*Triticum*) is one of the oldest of cultivated plants, known to have been grown in the Mediterranean portion of Asia and Africa by at least 4000 B.C. A species which may be close to the ancestral type is the Emmer Wheat found in Syria and Palestine; this is grown as a stock food in some of the western states. Wheat was introduced into Mexico by the Spaniards during the sixteenth century, and brought to Virginia and Massachusetts by the English colonists in the seventeenth. It was soon abandoned as a cereal crop in favor of the better adapted Maize. Wheat plants have moderately broad leaf blades and heads composed of fifteen to twenty spikelets on a zigzag axis. The grain is ovoidal in shape and cream, red or purple in color. The ovary wall and seed coat, rich in proteins, is known as the bran. Modern Bread Wheat has a large, nutritious grain as the result of thousands of years of selection and



Corn (*Zea Mays*) is one of the larger cultivated Grasses; the tassels are clusters of male flowers while the "ear" is a fleshy axis surrounded by pistillate flowers. Brooksville, Maine

hybridization. The first American wheat belt extended from Delaware and Maryland into New York. The pastry flour varieties of wheat are still grown there as well as in California and the Pacific Northwest. In succeeding years wheat was grown in the Ohio valley states, which today are the center for soft red winter wheats which are starchy and easily crushed. With the opening up of the great plains after the Civil War, ideal wheat country became available; an added impetus was the invention of harvesting and threshing machinery which made large scale production possible. In these states the hard wheats have become the favorite varieties. In the southern prairie states hard red winter wheat is grown, in the more northern ones thrive the hard red spring varieties; both of these are blended to make bread flour. The Durum Wheat, chiefly grown in Minnesota and the Dakotas, is used in making spaghetti and macaroni; in the process the ground-up wheat mixture is made into a dough which is forced through a press to produce the familiar tubular and stringy masses. Different types of flour depend upon the portion of the kernel used. Graham flour is made from the complete wheat kernel, and includes all the nutrients and vitamins of the bran as well as the endosperm and embryo. Whole wheat has part of the bran removed and uses about ninety percent of the kernel. Standard white flour uses only three quarters of the kernel, all the bran, protein layers and embryo being removed.

Rye (*Secale*) has wheat-like leaves and a long narrow spike bearing single spikelets at each node; it is one of the few cereal grasses which will thrive on poor sandy soils. A native of the Mediterranean region, it was known to the Greeks and Romans but not cultivated by them. Its extensive use did not begin until after the Middle Ages. Rye is an important food grain in Russia and Germany, but of minor importance in the United States. In addition to being used as a cereal, rye is the basis of many alcoholic beverages.

Barley (*Hordeum*) is, next to wheat, the most widely distributed cereal crop. A native of southwestern Asia, it was used by the Romans in making a heavy bread eaten by the soldier and peasant classes. Barley has blunter leaves than wheat and a straighter axis to the spike, which has three spikelets at each joint with long pointed awns. Since barley contains little of the gluten found in wheat, it cannot be made into a light bread. In the United States, barley is grown to a great extent in the inland valleys of California. Considered a food grain in the Old World, its chief use in this country is in preparing malt and as a food for livestock. Malt is the sprouted and dried barley grains; during the sprouting process the starch is changed to sugar. Malt is used in making malted beverages and in brewing beer. Several native species of *Hordeum* are known as Squirrel-tail Grass.

Darnell or Rye Grass (*Lolium*) is a member of the Barley Tribe with the spikelets arranged on two sides of a compressed spike; most of our species have been introduced from Europe. Quack Grass (*Agropyron*) is a related grass widely distributed through the central and western states.

The Millet Grass Tribe includes a number of related genera known as Millets, cultivated in Asia and Africa as a human food but grown in the United States and Europe for forage purposes. Panic Grass or Witch Grass (*Panicum*) is a large genus of five hundred species, widely distributed through the warmer portions of both hemispheres; over a hundred are found in our eastern, southern and central states. They are annuals or perennials with spikelets in open or compact clusters. Jungle Rice or



The Sedges (*Cyperaceae*) form extensive growths in the shallow waters of pond margins Brooksville, Maine.

Bamboos are the trees of the Grass Family, being perennial evergreens found in the tropics of the Old World; of two hundred species, the majority inhabit Asia and America, a few also being found in Africa. Our native member of the tribe, the Cane-reed (*Arundinaria*) grows in swamplands from Virginia to Florida and Texas where it forms the cane-breaks characteristic of many southern swamps; Cane-reeds are tall woody plants, often reaching a height of thirty feet, with flat leaf blades. Some of the foreign true bamboos are grown with success in our southern states. These



CYPERACEAE

Spike Rush, with inflorescence and spikelet; Bulrush with inflorescence; Sedge; and Sweet Rush.

true Bamboos (*Bambusa*, *Dendrocalamus*) are remarkable for the delicate massed effect of their foliage and close growth of stems, as well as for their tremendous height—sometimes of a hundred feet. Bamboos are among the most rapidly growing plants, instances being on record of a growth of eighteen inches in height per day. In the Orient, Bamboos are used for a great variety of construction and domestic purposes, and in making paper and textiles. The young shoots are edible and eaten like *Asparagus*. Like most of the grasses, the Bamboos grow in dense clumps rather than as single specimens.

THE SEDGE FAMILY

The Sedge Family (*Cyperaceae*) includes about three thousand species of widely distributed plants of relatively little economic importance. They often form extensive

The Palm Family



TO INHABITANTS of temperate regions, palms may seem exotic and curious trees which are highly ornamental as street trees in our southern cities or as decorative plants in hotel lobbies; it may come as a surprise to them to realize that the Palm Family is of as great economic importance to millions of dwellers in the tropics as any other family of plants is to us. For centuries palms have supplied almost all the needs of tropical peoples. They give grateful shade in blazingly hot deserts where few other plants can live; they produce edible fruits; furnish material for building and roofing houses, fibers for clothing, hats and textile uses; they supply sugars, oils and that important tropical betel nut from which a mastic is made which is chewed by one tenth of the human race.

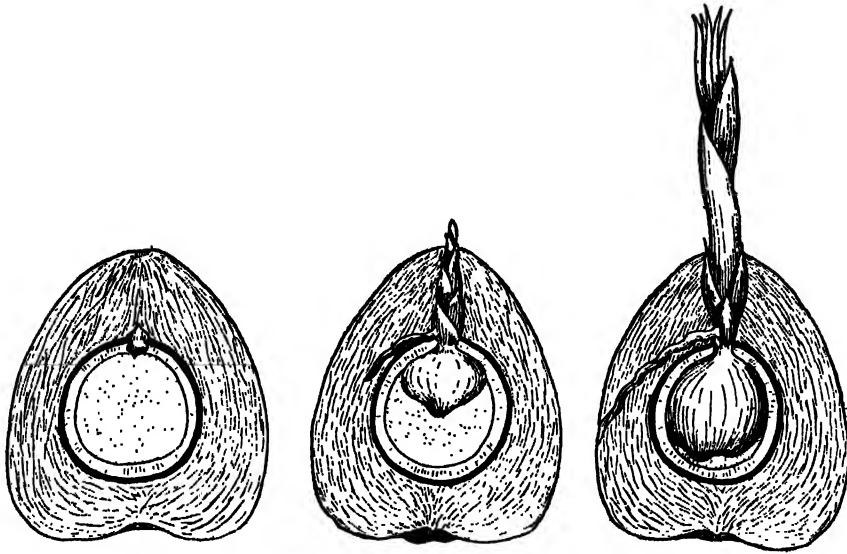
The Palm Family (*Palmae*) consists of twelve or fifteen hundred species of shrubs, vines and trees usually characterized by an unbranched stem or trunk topped by a cluster of relatively few, huge leaves. The trunk is often covered by old leaves or the bases of leaf stalks. Palm leaves are among the largest known, some of them reaching a length of fifteen feet; they are either pinnately (feather-like) or palmately (fan-shaped) compound, divided in many species into hundreds of slender leaflets. The trunks, unlike those of our common Dicot trees, are soft, having very little woody tissue; a palm stem is much like an enormous corn stalk, without the nodes. Most of the stem is a mass of pithy tissue reinforced by scattered vascular bundles, surrounded on the outside by fibrous or corky tissues. Since there is no growing tissue (cambium) under the bark, palm trunks do not grow indefinitely in thickness. The flower clusters are usually constructed on as huge a scale as the leaves; bunches of flowers ten or twelve feet in length hang down from among the crown of leaves. Each flower is small and greenish-yellow, made up of similar sepals and petals, and pollinated by the wind. The fruits are of various types of drupes, berries or nuts; the most familiar are the large drupe of the Coconut Palm and the berry of the Date Palm.

Palms can be conveniently arranged in two groups depending on whether the leaves are pinnately or palmately compound. The former, or Feather Palm, group includes only one species native to the United States—the Buccaneer Palm (*Pseudophoenix*) of the Florida Keys; this species is a rather small palm growing sparsely in the Florida Keys. Introduced palms with pinnately compound leaves include the

Coconut Palm, Date Palm, Royal Palm, Canary Island Palm and Plume Palm. The Fan-leaf group includes more American species, fewer introduced ones; the native representatives are the California Fan Palm, Cabbage Palm and Palmettos. Saw Cabbage Palm, Thatch Palm, Silver Palm and Needle Palm—most of them restricted to our southeastern states. Introduced ornamental varieties include the Hair Palm, Chinese Fan Palm, Blue Palm, Guadalupe Palm and Windmill Palm.

THE FEATHER-LEAF PALMS

Coconut Palms (*Cocos*) are tall slender trees with a trunk diameter of only one or two feet but a height of a hundred; the smooth gray bark is sometimes marked with



PALMACEAE

Germination of Coconut fruit. The milky portion of the endosperm is gradually absorbed by the enlarging cotyledon which eventually fills the cavity. The juvenile root is growing out at the left, the shoot upwards from the center, piercing the shreddy tissues which surround the seed. (adapted from Brown, "The Plant Kingdom." Ginn and Co.)

transverse rings. The open crown of leaves often presents a ragged and wind-swept appearance. Along the Florida seacoast these palms assume many picturesque slanting attitudes, showing the effect of trade winds. The Coconut Palm is the most widely distributed of all tropical trees, being found along seashores throughout the tropics. It is one of fifty species all of which are South American in their distribution. Although practically unknown in the wild state, it is considered to have been originally a native of that continent, whence it was dispersed westward in prehistoric times to the various Pacific islands. The coconuts are borne in clusters amid the leaf stalks, at the crown of the trunk. The fruit is capable of dispersal over water since the inner part (the coconut of commerce) is surrounded by light impervious fibrous tissues which keep it afloat for a long period of time; immersion in seawater has no injurious effects upon the seed within its protective husk. The three "eyes"



The Cabbage Palm (*Sabal Palmetto*) is the common Palm of the southeastern states, forming dense groves in the Everglades region. Everglades, Florida.

at the base. Far up the hundred or more feet of straight smooth trunk is a cluster of huge feathery leaves, from the base of which hang the golden yellow flower clusters. The Royal Palm has become a famous tree along the avenues of many a Florida city. It is considered by some botanists to be a vanishing type, native to Florida; it is now found sparingly in the Everglades, where a few veteran specimens can be found far from civilization; such can be seen in the Royal Palm State Park near the tip of the peninsula.

THE FAN-LEAVED PALMS

The California Fan Palm (*Washingtonia*), named in honor of George Washington, is one of three species native to southwestern United States and Mexico. It is a tall rangy palm with a rough trunk covered by a downward hanging thatch of old dried leaves which form a straw-colored covering for the trunk. The comparatively small crown of leaves seems insufficient to support the life of such a tall tree; each leaf is three to six feet long with forty to seventy segments, edged with fibrous threads. The leaf stem, or petiole, is armed with sharp hooked spines. The flowers are in the drooping cluster, characteristic of palms, changing to masses of elliptical black berries. This palm is native to the California deserts, especially the Colorado Desert; the best known grove, which includes a thousand or more trees, and gives a South Sea Island touch to the canyon is near Palm Springs. They are a characteristic street and lawn tree throughout southern and central California. The related species known as the Mexican Fan Palm is a taller more slender tree, and is also planted along streets and around homes. The streets and highways through the citrus districts of California are often lined by these tall palms.

In the southeastern states the most widely represented genus of the Palm Family is that comprising the Cabbage Palm and numerous Palmettos (*Sabal*). They include eighteen species of the United States, Central America and Mexico; all have smooth trunks and petioles. The shrubby species are quite characteristic of swampy and sandy ground of the coastal pinelands where they form a conspicuous feature of the undergrowth from North Carolina southward. The Dwarf Palmetto is a low plant with subterranean stem from which grows a crown of flat leaves, the segments lacking any fibrous threads along their margins. It grows in swamps and along streams from North Carolina to Texas. A closely related species known as the Delta Palmetto, found in the bayous of Louisiana, has a more erect stem and grows to a height of twenty feet. The common Scrub Palmetto of the Florida pinelands has folded and recurved leaves with thready frayed margins; the stem is subterranean and often spirally twisted. The Cabbage Palm is the common wild palm tree of Florida, growing with an erect stem to a height of sixty feet; it is found from the Carolinas to Florida, but reaches its best development in the magnificent groves along the rivers and swamps of Florida, often forming "islands" of tropical jungle growth amid the grasses of the Everglades. Its leaf blades are recurved and edged with filaments as in the Scrub Palmetto. The Saw Palmetto (*Serenoa*) is a shrubby plant of sand dunes and pinelands from the Carolinas to Louisiana; its leaves have spiny petioles, and the horizontal trunk sprawls over the ground like some huge black snake. Its branching habit is unusual for palms. The Saw Cabbage Palm (*Paurotis*) has an underground

The Arum Family and Its Relatives



THE Arum Order (*Arcales*) includes a group of plants with small flowers usually constructed of an inconspicuous perianth or none at all, enclosed in a pouch or borne in a cluster on a fleshy column known as a spadix; in some members of the order the spadix is seated in a conspicuous bract known as a spathe. There are two families in the order, representing two interesting extremes of plant development. In the Arum Family we find plants producing the largest inflorescences of the whole plant kingdom, while the Duckweed Family includes the smallest known flowering plants.

THE ARUM FAMILY

The Arum or Aroid Family (*Araceae*) includes about a thousand species, mostly tropical and herbaceous, commonly found in ponds, swamps and muddy habitats; many of them have large tuberous rootstocks, from which grow low masses of large coarsely veined leaves. Some have a pungent sap, due to the presence of biting crystals known as raphides. The flowers are small, with no sepals or petals, or with a perianth of only sepals; they are clustered on a spadix, usually enveloped by a large showy colored spathe. Our native species, all found in the eastern and central states, include Skunk Cabbage, Jack-in-the-Pulpit, Green Dragon, Water Lettuce, Sweet Flag, Golden Club, Water Arum or Wild Calla; introduced or interesting species are the Calla Lilies, the odd *Monstera* and the giant flowered *Aimorphophallus*.

A typical member of the family is the familiar Skunk Cabbage (*Symplocarpus*), one of the hardy pioneers that brings a touch of color to the barren late-winter woods, long before other spring flowers dare lift their heads above the sodden ground. The name, which does justice to the unpleasant odor of the bruised plant, hardly suggests the grace and color of the unusual hooded inflorescence which precedes the leaves. Each inflorescence consists of a purplish and green spathe which almost entirely surrounds the short globose spadix with its cluster of small flowers; after the flowers have disappeared, clusters of large coarse leaves take their place. Skunk Cabbage grows abundantly in swampy woods and meadows in all the eastern states, south to North Carolina and west to Iowa.

Another harbinger of spring is the Jack-in-the-Pulpit (*Arisaema*), a perennial Aroid with tuberous rootstock, starchy and acid, which is sometimes known as Indian Turnip. From this grow several compound leaves each with three leaflets,



ARACEAE

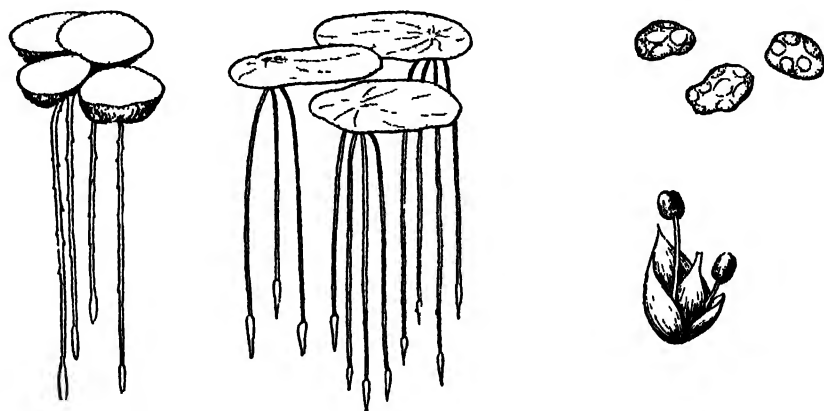
Sweet Flag (*upper left*), Golden Club (*upper right*), Skunk Cabbage (*lower left*), and Green Dragon (*lower right*).



Jack-in-the-Pulpit (*Arisaema triphyllum*) is a representative Aroid, its striped spathe being the "pulpit" for the spadix which is the "Jack." Hamilton, New York.

spreading out as a shield above the inflorescence. The latter is green with stripes of purple or darker green, the lower part of the spathe is cylindrical and entirely surrounds the spadix, the upper part arching over it to form a roof over the "pulpit" in which the "jack" or spadix is situated. The compact flower clusters change to a cylindrical mass of bright red berries in autumn. Our common Jack-in-the-Pulpit grows in rich moist woods throughout eastern United States. A related species, found in the same range and known as Green Dragon, has a tapering whip-like spadix and a more pointed green spathe.

Water Lettuce (*Pistia*) is a small pea-green aquatic plant found in streams and lakes from Florida to Texas, the strongly ribbed leaves are clustered on short branches, forming floating rosettes on the surface of the water. The small white flowers are



LEMNACEAE

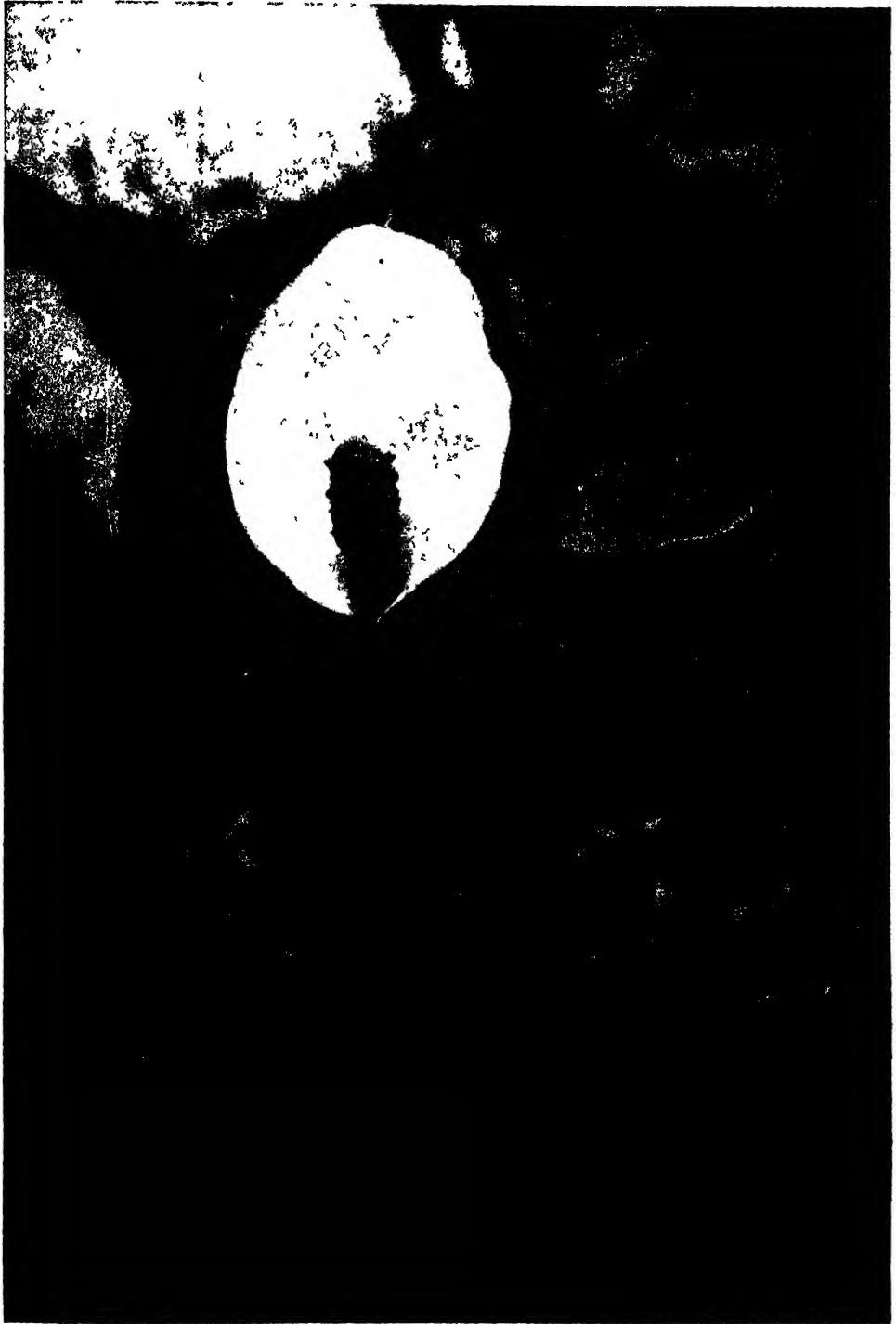
Common Duckweed, Large Duckweed and *Wolffia*, flower of Common Duckweed (lower right)

borne on a spadix which is closely attached to the spathe, found at the bottom of the cup of leaves. Water Lettuce is widely distributed throughout the tropics and can be used as an outdoor plant in garden pools in the warmer parts of the United States.

Sweet Flag (*Acorus*), found along stream margins and in swamps from New England to Texas, is found also in the Old World, related species are native to Japan. The leaves are long and sword-shaped, growing from an aromatic creeping rootstock, the upper leaves function as an open spathe, surrounding a lateral spadix bearing yellowish flowers.

Golden Club (*Orontium*) is another member of the family partial to swamps and ponds, found from New England to Louisiana. It has a deep rootstock and long-stemmed narrow floating leaves, the spathe of the flower is nothing more than a leaf sheathing the base of the flower stalk, which is terminated by a spadix with a compact mass of golden yellow flowers which suggest the name Golden Club.

Water Arum (*Peltandra*) found rooted in the mud in shallow ponds, in the same area as that of the Golden Club, has arrow-shaped leaves and a wavy margined green spathe; the flowers usually entirely cover the long tapering spadix. The more arctic Water Arum or Wild Calla (*Calla*) of cold bogs and lakes in our northeastern states



Wild Calla (*Calla palustris*) is a strikingly beautiful plant with its large pure white spathe beneath the spadix with its small flowers. Lake Placid, New York.



Calla Lilies (*Zantedeschia*) at the margin of a pool, Kellogg Gardens, Pomona, California.



Monstera is a strange evergreen vine from tropical America, with huge deeply lobed and perforated leaves. Huntington Botanical Garden, San Marino, California.

is a strikingly beautiful plant with heart-shaped leaves and an elliptical, pointed pure white spathe, resembling the much larger ornamental Calla Lilies.

The showy Calla Lilies (*Zantedeschia*) include eight species of aquatic or bog plants native to tropical and southern Africa, grown as ornamental pool plants in the warmer portions of the United States. The large, often spotted leaves, are spear-shaped with long petioles. Each flower has a large and flaring spathe with recurved tip, conspicuously colored and often hiding the central club-shaped spadix with its cluster of small flowers. The Common Calla of horticulture is a stout bog plant with a white or creamy spathe often ten inches in length. The Rose Calla, native to Natal, has a rosy pink spathe tinted purple on the inside; the Black-throated Calla of the same region has a straw-colored spathe with a dark purple spot at the base of the throat. Other species are yellow.

One of the strange woody plants of the Arum Family is the bizarre evergreen vine, *Monstera*, of Mexico and tropical America, often grown as a curiosity for its huge leaves, peculiar fruit and climbing habit. The vine grows by means of aerial roots which often encircle the trunk of the tree which acts as its support. In some species the large leaves are deeply lobed and perforated by numerous holes—a condition unique among the flowering plants and like that found in some of the Brown Seaweeds. The rather large inflorescence, consisting of a boat-shaped spathe which opens widely to reveal the cylindrical spadix—six to ten inches in length—is a tightly packed mass of greenish flowers; the berries are so close together in the fruit that it becomes like a cone in structure. This fruit is considered quite edible, with a taste halfway between that of a pineapple and a banana.

In the hot, humid forests of Sumatra grows the peculiar *Amorphophallus* or Krubi, which produces the largest inflorescence in the plant kingdom. First comes the leaf on an erect, heavy stalk which may rise five feet above the soil. At its tip expands the blade divided into many leaflets. After a series of leaves has come and gone, the inflorescence emerges from the same underground corn, which may weigh from 50 to 100 pounds or more. When the flowering structure begins to push through the ground, it appears as a pointed cylinder which elongates rapidly; in less than two weeks it may exceed the height of a man; then the spathe expands to form a graceful vase-shaped structure of gigantic size, four feet or more in diameter and equally high; it is yellowish without and grades into a rich deep purple in the throat. From the center of this huge, colorful envelope the relatively slender spadix will have risen as a tubular column having the texture and color of chamois skin. The entire growth eventually may reach a height of eight feet or more, with the small pistillate and staminate flowers hidden from sight at the base of the spadix. While the inflorescence is unfolding, a fetid odor is given off, similar to that of Skunk Cabbage but magnified as one might expect. An *Amorphophallus* "in captivity" once made history at the New York Botanical Garden by flowering and remaining open for several days while a stream of visitors came to view the strange plant; a credulous photographer, warned of the terrible odor, came prepared with a gas mask!

THE DUCKWEED FAMILY

It is a great jump from the one extreme of a flower much taller than a man to the minute specks of green which make up the entire plant body of the various members

CHAPTER XLII

The Lily Family and Its Relatives



A GREAT number of showy flowered herbaceous plants and vines and a few trees are grouped in the large Monocot order *Liliales*; the leaves are usually grass-like or fleshy, often three to six feet long, and the flower consists of six members which are often colored alike, giving the appearance of a six-petaled perianth. Many species are characterized by bulbs and rootstocks. The Lily Order includes, among others, the Lily Family, Amaryllis Family, Iris Family and Rush Family.

THE LILY FAMILY

The Lily Family (*Liliaceae*) is a large one, numbering over twenty-five hundred species. Many of them grow from underground stems and buds known as bulbs, from which grow erect clusters of narrow grass-like leaves or leafy stems; in some of the succulent members of the family, these basal rosettes are made up of thick, sharply pointed leaves which function as storehouses of water. The perianth usually consists of six similar segments, sepals and petals looking alike, in some cases fused at the base to form a tubular corolla. Most of the species are herbaceous, though woody tree members are also found in the family. Some of the native, widely distributed species include Mountain Asphodel, Blazing Star, the Featherlings, False Hellebore, Bunchflower, Wild Onion, Bellwort, Dog's-tooth Violet, the True Lilies, Solomon's Seal, False Solomon's Seal, Canada Mayflower, Twisted Stalk, Dogberry, Indian Cucumber Root, Cat Brier, the Trilliums and Lily of the Valley. Typically western species include, in addition, Sand Corn, Sand Lily, Soap Plant, Camass, Desert Lily, the Brodiaeas, Fritillary, Mariposa Lilies and Fairy Lantern. Native succulents are found in the *Yucca* genus, which includes Bear Grass, Spanish Bayonet and the unusual Joshua Trees. Of the introduced and cultivated members of the family, we might mention Asparagus, Onion, Garlic, Leek; the succulent Aloes, Gasteria and Haworthia; the familiar Tulips and Hyacinths; and the Dragon Trees.

Mountain Asphodel (*Xerophyllum*) is a stout plant found in sandy woods from New Jersey to North Carolina, with wry or needle-like leaves growing in tufts about its base and becoming bristly bracts on the flowering stalk; this is terminated by an elongated cluster of small flowers with spreading white sepals and petals. A species known as Elk Grass or Fire Lily, with creamy white flowers, grows on dry ridges from California to Washington.

In moist woods from New England to Florida and Michigan grows the Blazing Star (*Chamaelirium*), a fleshy plant with a few spreading basal leaves and a long narrow cluster of green or white flowers. Another genus with greenish-white flowers is that containing False Asphodel or White Featherling (*Tofieldia*), a slender tufted plant with compact clusters of small flowers, found in pinelands from North Carolina to Georgia. The Wood Featherling, like the other species in having petals longer and more concave than the sepals but with more hairy foliage, ranges from New England across the continent to Oregon, southward to North Carolina.

The erect leafy stems of False Hellebore or Indian Poke (*Veratrum*) are familiar



LILIACEAE

Mountain Asphodel, Blazing Star, Wood Featherling.

sights in eastern swamplands, where they grow intermingled with the masses of Skunk Cabbage leaves. The leaves of False Hellebore are large and coarse, with lengthwise pleats; at the summit of the plant is borne the large branching cluster of small yellowish-green flowers. Western False Hellebore or Corn Lily is a similar plant with greenish-white flowers, found in wet meadows from the Pacific coast to the Rocky Mountains.

Bunchflower (*Melanthium*), one of three eastern species, is a coarse plant of wet woods from New England to Texas and Minnesota, with a tall leafy stem clothed at the base by long narrow leaves. The greenish-yellow flowers consist of six pointed segments, each with a broad blade and a narrowed basal portion.

The Onion genus (*Allium*) includes three hundred widely distributed species, of which the bulbs are made up of many successive overlapping layers of leaf bases, and the slender tapering leaves have the familiar onion or leek taste; when in blossom, Onions bear white or pink flowers in umbel-like clusters. The native kinds include



The Wood Lily (*Lilium philadelphicum*) has orange-red terminal flowers, purple spotted on the inside. Brooksville, Maine.

over two dozen western species, less than a dozen eastern ones. Eastern Wild Leek is a plant growing in rich woods in the northeastern states, the leaves appearing early in spring and withering before the erect greenish-white flower umbels mature. Wild Onion, which is found on rocky hillsides and prairies from New York southwestward, has nodding umbels of rose-purple flowers. Wild Garlic, occurring in the same area, bears small bulblets in place of most of the flowers in the erect umbel. The common garden Onion is not found today in the wild state, it was cultivated by the early inhabitants of India, Egypt and China, and was grown throughout Europe before the discovery of America. This species has hollow leaves and large bulbs of papery leaf bases, the bottom of the bulb being the small shortened stem. Most of our home consumed crop of onions is grown in Texas and California. Garlic, a species native to



LILIACEAE

False Hellebore, Bunchflower and Wild Leek

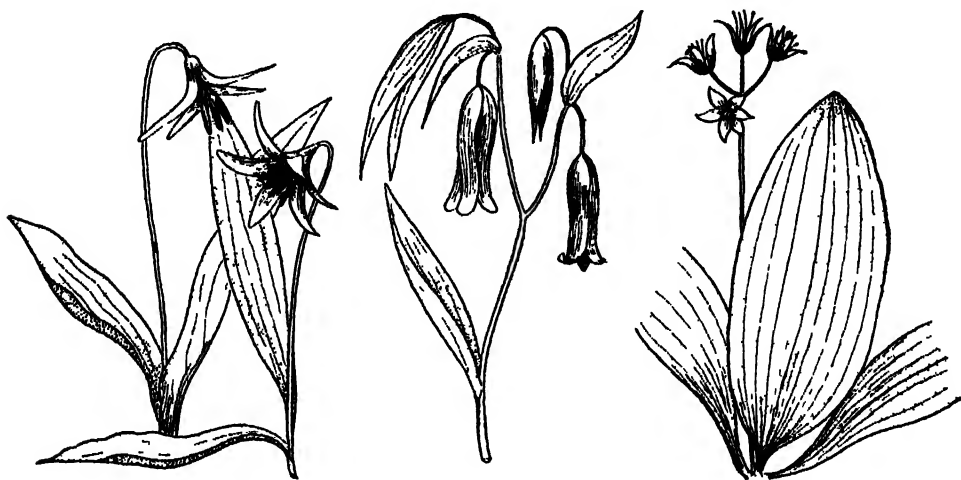
southern Europe, has thick flat leaves and clusters of small egg-shaped bulbs all enclosed in a whitish sac, both the small bulbs and the leaves are used as seasoning. Another familiar member of the genus is Leek, also a native of the Mediterranean region, it has broad keeled leaves, the bottom portions of which are used in seasoning or eaten much as is asparagus. Chives is another edible species.

In the Bellwort (*L. vulgaria*), a delicate plant with ovate pointed leaves, the leaf bases entirely surround the stem—a condition known as perfoliate; the terminal yellow, drooping flowers are narrowly bell-shaped with six pointed segments. This species lives in rich woods, and is found from New England to the Dakotas and southward. The Large-flowered Bellwort also has perfoliate leaves, but these are hairy on the undersurface, it occurs from New England to Georgia and Minnesota. The Sessile-leaved Bellwort (*Oakesia*) of moist woodlands of the eastern states has an angled stem with clasping leaves (not perfoliate) and nodding pale yellow flowers in the leaf axils.



The Canada Lily (*Lilium canadense*) has nodding yellow or orange flowers, sometimes spotted with brown Brooksville, Maine

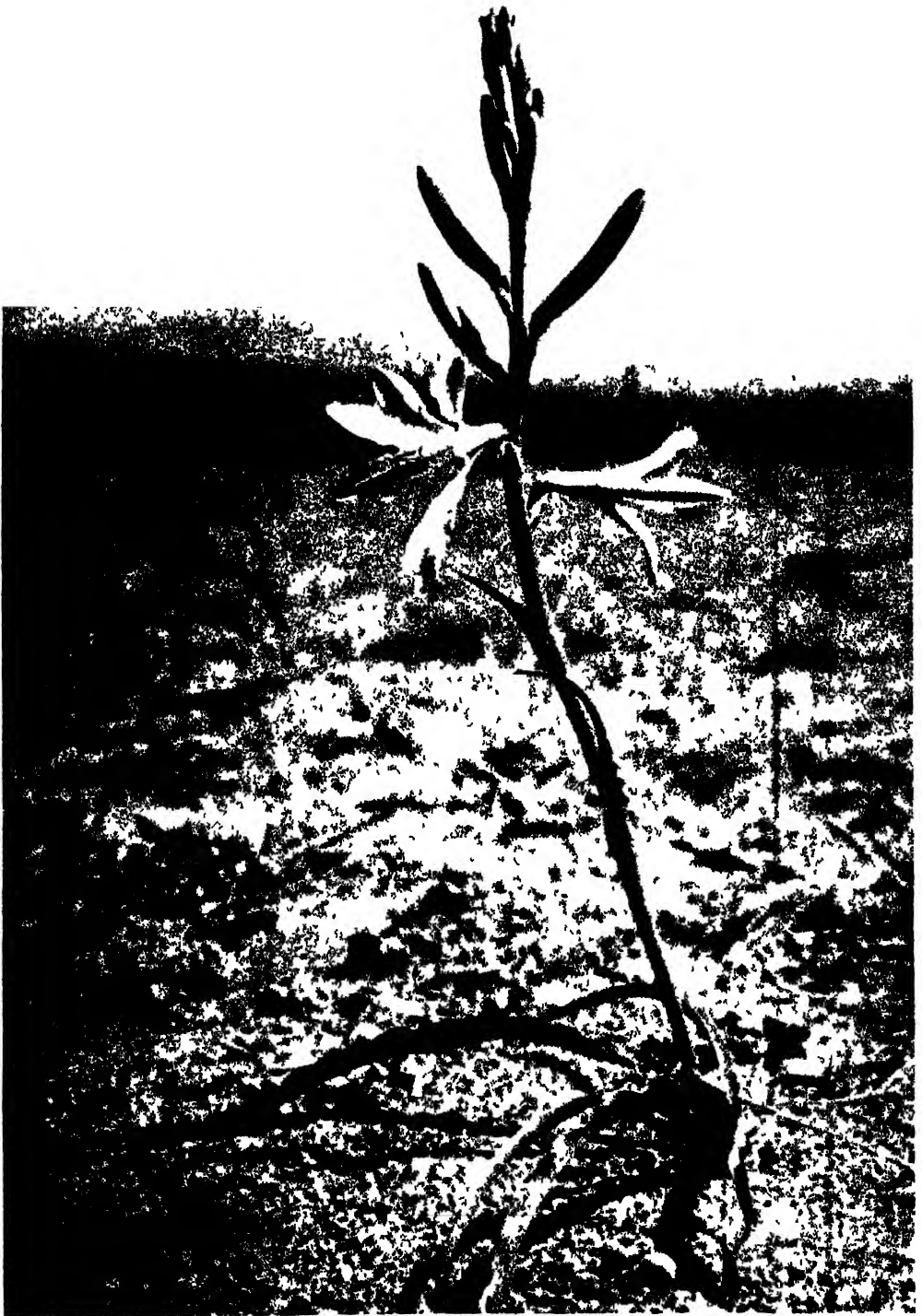
The Dog's-tooth Violet is often found in company with those other two early spring flowers, Hepatica and Spring Beauty. There are many North American species of Dog's-tooth Violets or Adder's Tongues (*Erythronium*), all small but attractively flowered plants with a pair of basal leaves which are often mottled with purplish-brown spots. Yellow Adder's Tongue is a common species of rich eastern woodlands, its light yellow nodding flowers having six narrow segments which are spreading or recurved at maturity. A more rare eastern plant is the White Dog's-tooth Violet, with pinkish-white flowers and less spotted leaves. A related species with yellowish-white flowers, known as the Fawn Lily—one of seven western members of the genus—grows on open hillsides in California.



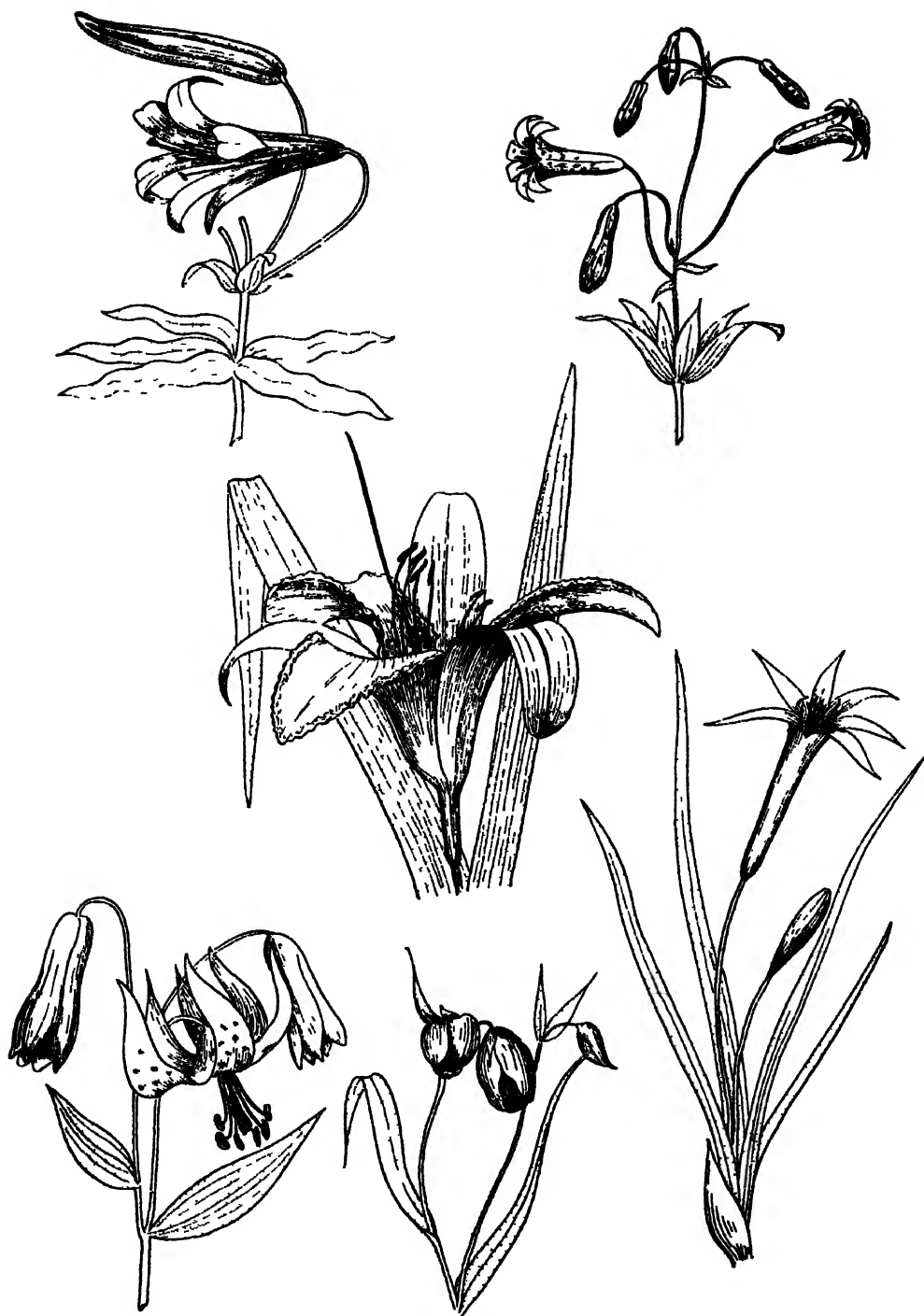
LILIACEAE

Dog's-tooth Violet, Sessile Bellwort and Dogberry

The true Lilies (*Lilium*) include some hundred north temperate species of large and beautifully flowered plants, of which the United States has a generous share. Few plants are so delicately and strikingly colored. Common eastern members of the genus include the Wood Lily, the Southern Red Lily, Turk's Cap Lily and the Wild Yellow Lily. The Wood Lily has whorls of narrow leaves on its erect stem, with one to three erect terminal flowers, each with six orange-red segments, dark purple spotted on the inside; it prefers dry sandy ground, and is found in such locations throughout most of the states east of the Mississippi River. The Southern Red Lily or Leopard Lily is a closely related species with solitary scarlet flowers, found on pine barrens of the southeastern coastal plain states. Turk's Cap or Royal Lily, a flower of rich woods from New England to Virginia and west to Minnesota, has whorled lower leaves and nodding orange flowers, the inside of the recurved petals and sepals being marked with purple spots. The Wild Yellow or Canada Lily also has nodding flowers; these are yellow or orange, with recurved segments and usually spotted with brown,

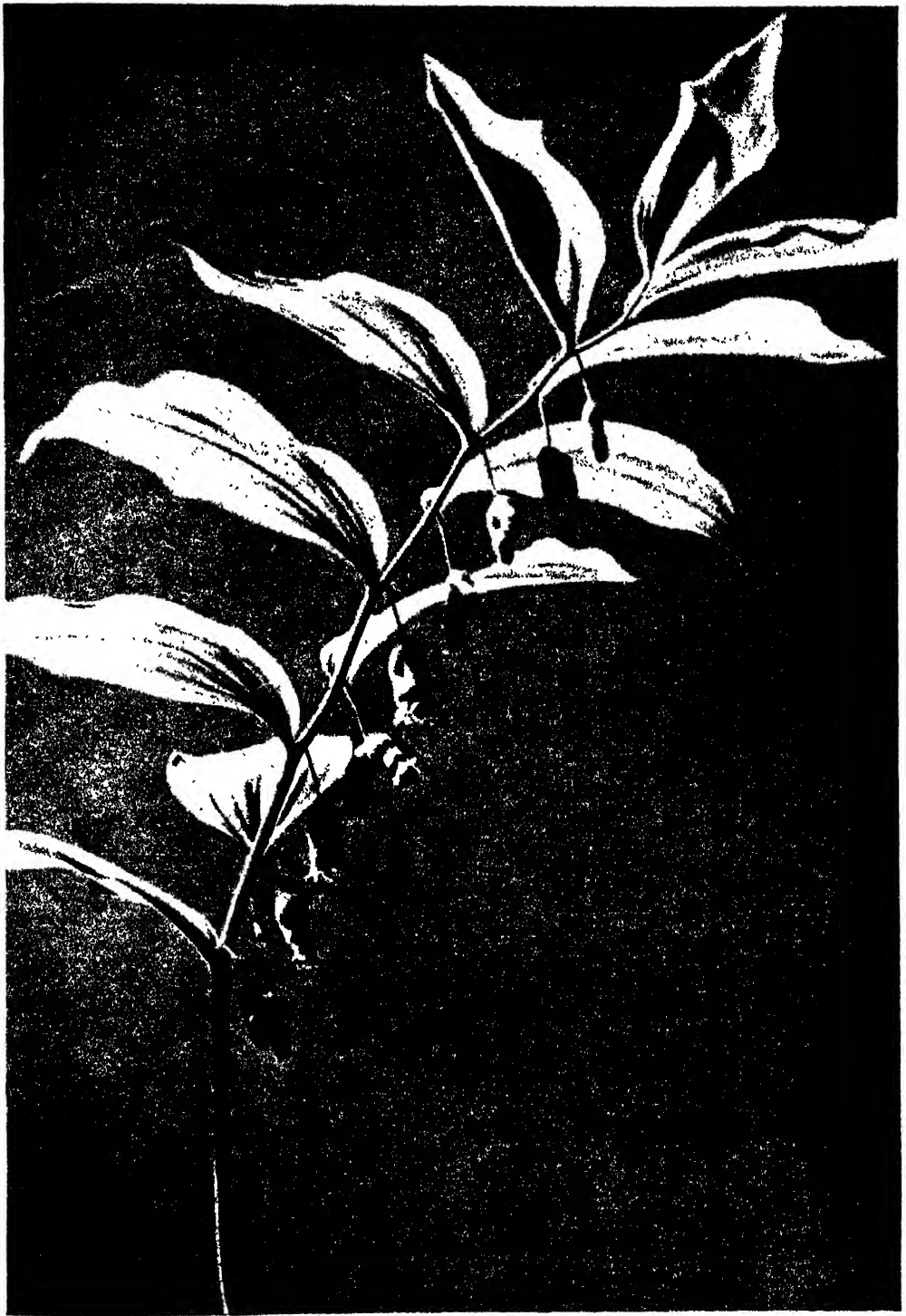


The Desert Lily (*Hesperocallis undulata*) displays its large, silvery white blooms amid the most barren of desert surroundings. Twenty Nine Palms, California



LILIACEAE

Day Lily (*center*), Washington Lily (*upper left*), Little Leopard Lily (*upper right*), Turk's Cap Lily (*lower left*), Fairy Lantern (*lower center*), Sand Lily (*lower right*).



Solomon's Seal (*Polygonatum biflorum*) has small greenish bell-shaped flowers and blue-black berries. Hamilton, New York.

borne on long stems in a terminal cluster. This rather common representative of the genus grows in wet woods of the northeastern and north central states.

The numerous western species of *Lilium* include the Washington Lily, Lemon Lily, Tiger Lily, Redwood Lily, Oregon Lily and the Little Leopard Lily. The Washington Lily found in the pine forests of California and Oregon, has pure white, large, fragrant blossoms similar to those of the Easter Lily. The Lemon Lily, living in moist places on the high mountains of southern California and Arizona, also has



IRIDIACEAE

Lily of the Valley (upper left), Two-leaved Solomon's Seal (lower left), Cat Brier, Indian Cucumber Root (right)

fragrant flowers, yellow with dark spots. One of the taller members of the genus is the Tiger or Humboldt Lily, often six feet tall, bearing whorls of ten to twenty leaves and nodding orange-red flowers, it is found in the southern California mountains. The Redwood or Chaparral Lily has white flowers, smaller than those of the Washington Lily, and is found near the coast in the Redwood forests of California. More extensive in its range, being found in all the Pacific coast states, is the Oregon Lily with reddish-orange flowers spotted with purple. The Little Leopard Lily, occurring along streams and in swamps from California to Oregon, has several small orange-yellow flowers, spotted with purple.

Many of the native species are cultivated for their showy flowers, but in addition



False Solomon's Seal (*Smilacina racemosa*) is a stout and coarse plant with strongly veined leaves and bushy clusters of small white flowers. Hamilton, New York.

there have been introduced many familiar varieties. The common Easter Lily, grown to such an extent in Bermuda, is a native of China and Japan, its waxy-white blooms hardly need description. The Madonna Lily, a white-flowered species from southern Europe and Asia, is thought to be the lily so frequently referred to in the Bible, its flowers are smaller than those of the Easter Lily. The Garden Tiger Lily has salmon-red flowers with black-spotted reflexed segments which do not fuse to form the tubular base distinctive of most other Lilies, this species comes from China and Japan.

Many of the plants popularly known as Lilies belong to various other genera. The Day Lily (*Heimerocallis*) is a Eurasian plant often found naturalized along roadsides,



LILIACEAE

Death Camass, Soap Plant and Western Camass

it has long narrow leaves like those of the Cat-tails and leafless flowering stalks bearing clusters of erect bright orange flowers with the three inner segments characterized by a wavy margin. The plant derives its name from the fact that the flowers last for only a day. The western Sand Lily (*Leucocrinum*) grows in mountain valleys from Oregon to Nevada and Nebraska, from the tufted mass of leaves arise flowering stalks bearing clusters of fragrant white flowers. One of the most delicately beautiful of the whole Lily Family blooms amid the arid wastes of the California deserts, this Desert Lily (*Hesperocallis*) is often the sole form of life on barren sandy stretches baked dry by the desert sun. The gray-green long narrow leaves arch over and rest on the ground, from their midst rises the flowering stalk with its cluster of large flowers with spreading sepals and petals—greenish- and silvery-white. Chocolate Lily, also known as Mission Bells (*Fritillaria*), has nodding brownish-purple flowers, borne singly or in small clusters, it grows on grassy slopes in California. One of the most beautifully tinted members of the family is the western Mariposa Lily (*Calochortus*), whose common name is the Spanish word for butterfly, and whose scientific name means



Twisted Stalk (*Streptopus amplexifolius*) bears nodding bell-shaped greenish-white flowers and, later in the season, scarlet berries Brookville, Maine.

"beautiful grass". Mariposa Lilies have long narrow basal leaves and slender stiff stems terminated by usually a single showy flower with three narrow green sepals and three broad white petals which are sometimes tinted yellow, rose or lilac. Each petal has a hairy yellow base painted with purple or red spots. These choice flowers grow on dry mountain slopes of California and the far western states. The Desert Mariposa Lily is another Californian species with sepals colored orange-red on the inside, and bright vermilion petals with hairy and purple spotted base. A species known as Fairy Lantern has nodding globose flowers with incurved white petals, and long narrow green sepals. Both of these are natives of California.

Hairy Solomon's Seal (*Polygonatum*) is a small flowered member of the Lily Family with ovate and strongly parallel veined leaves, and greenish bell-shaped, nod-



LILIACEAE

Golden Brodiaea, Common Brodiaea and Yellow Mandarin..

ding flowers—usually borne in pairs—in the axils of the leaves; the globular berries are black or blue in color. Hairy Solomon's Seal typically grows on rocky slopes, throughout all the eastern and central states. Along streams and in moist thickets grows the Great Solomon's Seal, found from southern New England to Georgia and west to the Rocky Mountains; it is a more robust plant with larger flowers. False Solomon's Seal (*Smilacina*), also known as False Spikenard, is a stouter and coarser plant, with slightly zigzag stem and alternate strongly-veined leaves, native to moist banks throughout the eastern states. The very small white flowers form large bushy clusters at the end of the stem; in autumn they change to red berries.

Twisted Stalk (*Streptopus*) with conspicuously zigzag stem, grows along the margin of cold streams in a transcontinental range, in the northern tier of states; its forking stems bear nodding greenish-white bell-shaped flowers in the axils of ovate leaves, and later in the season, scarlet berries. A related northeastern species, Rosy Twisted Stalk, is similar in appearance but has rose-red flowers.

Two-leaved Solomon's Seal, sometimes known as Canada Mayflower (*Maianthemum canadense*), is a diminutive relative found in moist woods, often at the base



Red Trillium (*Trillium erectum*), like all the Trilliums, has its leaves and flower parts in threes. Hamilton, New York

of trees, in our northeastern states, the angled stem bears two or three elliptical leaves and a terminal cluster of small white flowers each with four spreading segments and conspicuous stamens. The fruits are red-speckled, greenish-brown berries.

Dogberry or Yellow Clintonia (*Clintonia*) is a small plant, usually with three large oval basal leaves and an erect stalk terminated by three to six drooping flowers with six narrow yellow segments, the berries are blue. It grows in cool moist woods of New England, west to Minnesota and south to North Carolina. The White Clintonia with smaller erect white flowers and black berries is common in the southern Appalachian region. This species is also known as the Speckled Wood Lily because



ILLUSTRATION

Asparagus—edible stem, flower section and portion of fern-like branch, Hyacinth

of the green or purple dots on the perianth segments. Of the western species Bride's Bonnet, with solitary white flowers, is found in the coniferous forests of northern California.

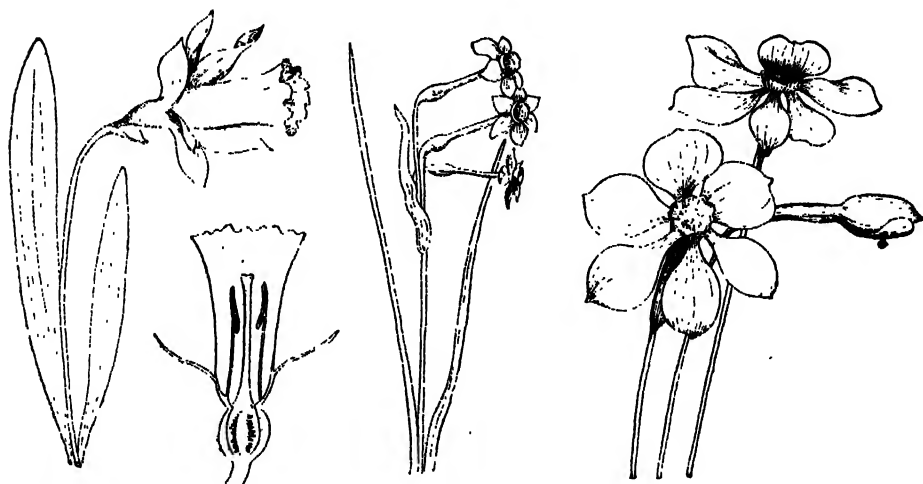
Indian Cucumber Root (*Mediola*) of our rich damp eastern woodlands gets its name from the white tuber with a cucumber taste. The tall straight stem bears two whorls of elliptical leaves, the uppermost smaller and beneath the umbel of several blossoms. These are yellowish-green flowers with recurved petals and sepals and a prominent three-parted tip to the also recurved pistil. The berry is dark purple in color. The scientific name was adapted from that of Medea the sorceress, because of supposed medicinal value of the plant.

Shrubby or climbing representatives of the Lily Family include the Cat Briers (*Smilax*), which usually have prickly stems and tendrils. The Common Greenbrier of the eastern states has rounded leaves and axillary umbels of small greenish-yellow flowers, followed by blue-black berries. Many other species are found from coast to coast.



The Tree Yuccas (*Yucca treculeana*) of Texas have stiff radiating leaves, and the typical erect cluster of creamy-white flowers. Columbus, Texas.

The *Trillium* genus includes some twenty North American species of low-growing plants with large showy flowers. The name comes from the Latin word for three (*tres*), since the stem bears a whorl of three leaves and the flower has three green or brown sepals and three colored petals. The common Red Trillium or Wake-robin, found in eastern woods, has purplish-red petals and a bright red fruit. A similar plant found in the east and midwest, the Sessile Trillium, has purple flowers. The White Trillium of wooded ravines in our northeastern and north central states has white erect flowers turning pink with age; while the Nodding Wake-robin, found in the same area, has nodding white flowers with recurved petals. A conspicuously colored member of the genus is the Painted Trillium found in cool moist woods and bogs of



AMARYLLIDACEAE

Daffodil and section of flower, Jonquil and Narcissus.

the northeastern states; the erect flowers have white petals marked with red or purple stripes.

Lily of the Valley (*Convallaria*) is a slender plant found in the high mountains from Virginia to South Carolina, the same species also occurring in Europe and Asia. The underground running rootstock gives rise to a short stem bearing a few oblong leaves and one-sided clusters of small fragrant white flowers with bell-shaped perianths. The rhizomes and roots, though poisonous in large doses, are used as a heart tonic.

The remaining native members of the family are found in the western states. Sand Corn (*Zygadenus*) has narrow grass-like leaves, topped by an open cluster of flowers with green or white sepals and petals; it thrives on sagebrush hills from the Pacific coast to Montana. A related species with white flowers, known as Death Camass because the leaves are fatal to sheep, has a more restricted range along moist grassy hillsides from California to Washington. There are several other eastern and southern species. Soap Plant (*Chlorogalum*) has long grass-like leaves which often



Mariposa Lily (*Calochortus venustus*) is one of the most colorful of the western members of the Lily Family. Sequoia National Park, California.

leaves and huge flower clusters on towering stalks often five or ten feet in height. There are about thirty species native to Mexico, the West Indies and the United States—especially common from Texas westward to the Pacific coast. Bear Grass or Adam's Needle of the southeastern states has very slender linear leaves which are edged with loose fibrous threads; these leaves form a compact basal rosette, from the center of which rises a flowering stalk four to twelve feet in height, bearing a cluster of nearly white flowers, each with six segments. It is a plant of sand hills and fields. Two closely similar species are the Spoon-leaf Yucca with concave spoon-shaped lower portion to the leaves, found from Delaware to Georgia, and the Weak-leaf



JUNCACEAE AND IRIDACEAE

Rice Rush (*left*), Crocus (*center*) and Gladiolus (*right*).

Yucca with less rigid leaves, occurring from North Carolina to Alabama. The familiar Spanish Bayonet of sand dunes and similar habitats from North Carolina to Florida often has a woody trunk ten feet in height and stiff flat leaves two inches in width, slightly toothed or thready along the margin; the flowers have a reddish tinge. The Spanish Bayonet of the Southwest is another species, with concave leaves and a shrubby habit, rarely producing a central trunk. The Aloe Yucca common in the Gulf states, north to Virginia, has thick fleshy recurved leaves and a trunk growing to a height of six feet. Farther west in the Texas region grows the Tree Yucca which has a branching habit, the branches being terminated by stiff clusters of radiating leaves; these are smooth-margined or only slightly thready. Typically southwestern species include Spanish Dagger, Desert Candle and the Joshua Tree. Spanish Dagger is a shrub or tree with a trunk twelve feet in height, clothed with stiff yellow-green leaves edged with coarse fibrous threads; this species grows on rocky mountain slopes from the California deserts to Nevada and Arizona. Striking sights on the grassy tree-



Desert Candles (*Yucca Whipplei*) are striking sights, the basal rosette of sharply-pointed leaves giving rise to the tall flowering stalk terminated by the huge and fragrant cluster of flowers San Jacinto Mountains, California.

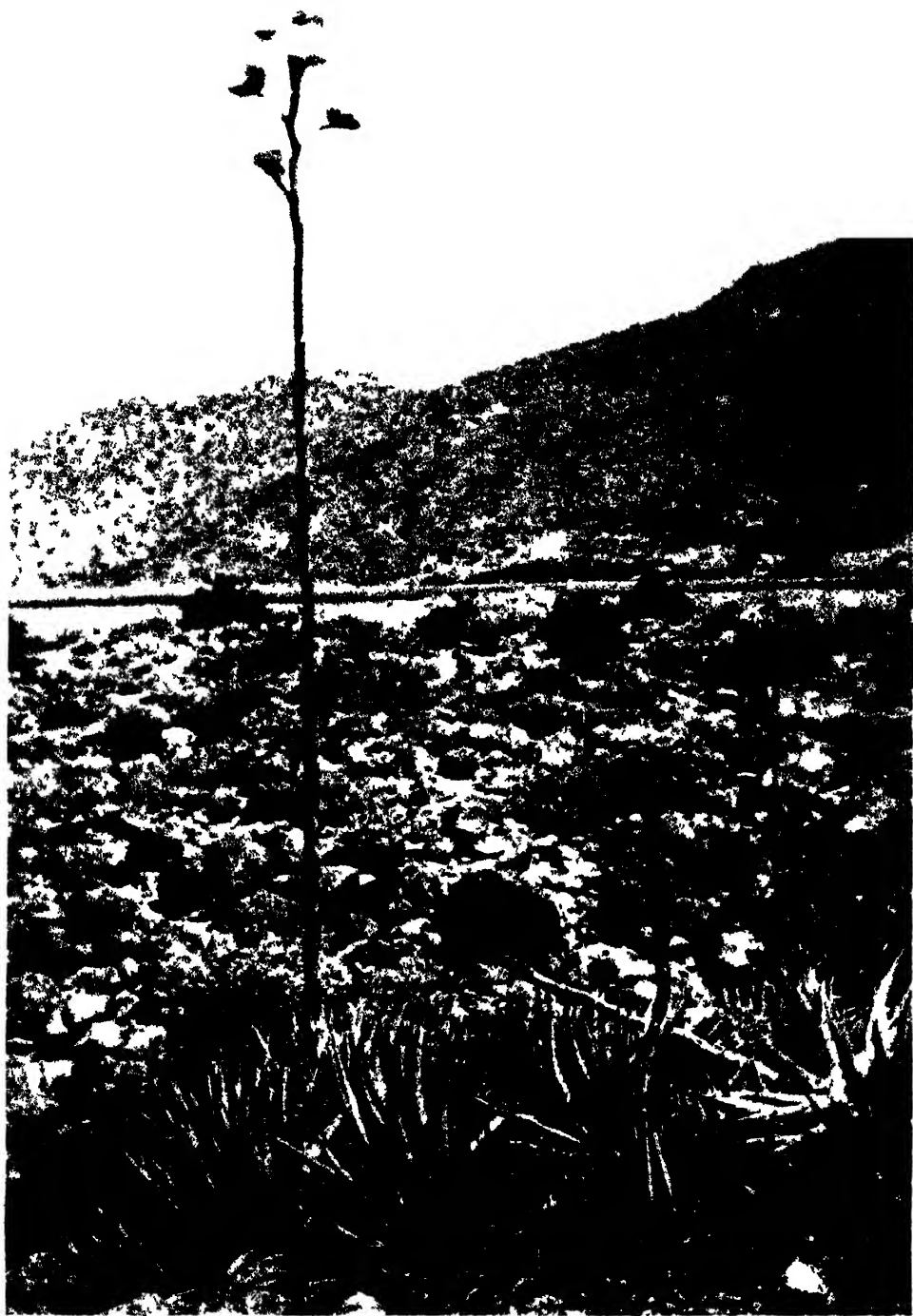
less hillsides of southern California are the Desert Candles in blossom. This species of *Yucca* forms porcupine-like rosettes of basal narrow leaves, from the midst of which rises the stout flowering stalk terminated by an immense cluster of pendant creamy-white flowers. A hillside covered with these *Yuccas* looks like an area dotted with tall graceful candles.

Our Southwest is the home of many strange and curious plants, none more grotesque than the species of *Yucca* known as Joshua Tree, which frequently reaches a height of thirty or forty feet. The woody trunk branches to form an irregular head, the terminal branches being bent and twisted in various directions, and covered with an armor of short stiff narrow leaves. The name is said to have been given these trees by the Mormons when they were crossing the California deserts on their way to Utah, the bizarre branches seeming to the wanderers to look like the outstretched arms of a Joshua leading them on their way out of the wilderness. On the rocky slopes of the borders of the California deserts, northward, forests of these Joshua Trees lend a nightmarish aspect to the scenery. A particularly fine forest, scattered over many square miles of rocky hills east of Palm Springs, has been set aside as the Joshua Tree National Monument with the hope of preserving these unique trees of the Lily Family for posterity.

There are several introduced genera which are familiar cultivated plants, such as *Asparagus*. Tulips, Hyacinths, Dragon Tree, Aloes and other succulents. *Asparagus* (*Asparagus*) is a large genus of Old World plants, unusual in that the leaves are reduced to small scales, while the numerous thread-like branches are green and function in place of leaves. The flowers are small and greenish-yellow. *Asparagus* plants consist of matted rootstocks from which grow thick succulent shoots whose scales are degenerate leaves; these shoots are the edible portions of the Garden *Asparagus* which grows wild in the salt marshes of Europe and Asia, where it has been under cultivation for over two thousand years. The delta section of California produces most of the American crop; other producing states are New Jersey, Illinois, South Carolina, Georgia and Massachusetts. The *Asparagus Fern* commonly used by florists is not a true fern but a species of *Asparagus* from South Africa which is a woody climber with flattened leaf-like structures (cladodes) forming fern-like sprays.

There are about fifty species of Tulips (*Tulipa*) native to Siberia, Turkey, Asia Minor, China, Japan and the Mediterranean countries. Tulip plants grow from a large underground bulb, producing chiefly basal leaves; at the top of the erect flowering stalk is the single flower, consisting of petals and sepals colored alike. The name Tulip comes from the Persian word for turban, in reference to the shape of some of the flowers. Tulips, previously cultivated by the Turks for hundreds of years, were introduced into Europe in the middle of the sixteenth century. Today Holland produces the major share of bulbs. The early Turkish varieties were yellow or red with pointed petals; since the influence of European breeders, the trend has been to broader petaled types of various light colors, and brown and black. For a time they aroused so much interest among fanciers that prize bulbs brought fanciful prices, and "tulipomania" was a prevalent craze.

The Hyacinth (*Hyacinthus*) has been under cultivation for the last four hundred years; the cultivated species is a native of Greece, Syria and Asia Minor, with relatives in South Africa. The strap-shaped leaves are all basal; the fragrant bell-shaped



The Desert Century Plant (*Agave deserti*) is native to our southwestern deserts, producing a terminal cluster of yellow flowers. Twenty Nine Palms, California.

The cultivated Paper Narcissus (*Narcissus*) is familiar to everyone; but the genus includes also the Daffodils and Jonquils. These are a few of the two dozen species native to Europe, Siberia, China, and Japan; they are characterized by tapering flat leaves and showy yellow or white flowers, borne singly or in small clusters. The tubular flower has six spreading segments, with the throat bearing a trumpet- or cup-shaped crown known as a "corona". The Paper Narcissus has broad and spreading, pure white segments with a lemon-yellow corona, white with a red margin. Jonquils have narrow and rush leaves and a creamy white or yellow flower with a small cup-shaped corona. Daffodils also have white, cream or yellow flowers; but the leaves are flat and the conspicuous corona is often as long as the entire perianth.

THE IRIS FAMILY

The Iris Family (*Iridaceae*) is another large family of the Lily Order, with over a thousand widely distributed species. Like so many other members of the order, the leaves are narrow and grass-like or sword-shaped. The characteristic features of the Iris Family are found in the flowers, which have inferior ovaries as in the Amaryllis Family, but only three stamens instead of the six found in that group of plants. Sepals and petals are colored more or less alike. Our native representatives of the Iris Family are the Blue Flags or Irises, Blue-eyed Grass and Celestial Lily; cultivated genera include *Gladiolus* and *Crocus*.

The *Iris* genus is well named, for "iris" is the Greek word for rainbow and appropriately suggests the variety of colors found in the flowers, whose reflexed petals and erect sepals, narrowed at the base, are frequently colorfully tinted. Large Blue Flag is a stout-stemmed plant with long sword-like leaves and purple-blue flowers variegated with yellow or white and veined with purple; it is a common inhabitant of swamps throughout the northern tier of states. Almost a hundred other species are found in the eastern and southern states, while the genus is poorly represented on the Pacific coast. The Slender Blue Flag has a more slender stem and smaller flowers; it grows in marsh lands near the coast from New England to Georgia. The Violet Dwarf Iris is a colorful species of rich woods from Pennsylvania south to Mississippi, with its violet-blue petals, and sepals tinted orange-yellow at their base. The Crested Dwarf Iris is a closely related species with crested sepals, found from Maryland to Georgia. The Copper Iris growing in swampy woods of Illinois south to Georgia and Texas has brownish-yellow flowers marked with blue and green. Of the western species, the Sierra Iris of the California mountains has large yellow flowers with lavender veins, or light lavender flowers with darker purple veins. Western Blue Flag grows in wet meadows from the Rocky Mountains to the Pacific coast; it has pale blue or white short petals and pale blue sepals veined with purple.

The Fleur de Lis or German Iris is the species from central and southern Europe from which many of the cultivated varieties have arisen; they vary in color from white to mauve, blue and deep purple. The Yellow Fleur de Lis is another ancestral type with numerous garden offspring. Japanese Iris, native to Siberia and Japan, has blue flowers marked with yellow; this species was introduced into Europe in 1857. European Irises thrive particularly well in a climate where they are kept warm and dry in summer, and thus are commonly grown in California; the Japanese species prefer a cooler moister climate. Orris Root—derived originally from iris-root—is



A Mexican *Agave Shawii* on the seacoast near Ensenada, Mexico

made from the German Iris, whose violet-scented roots are ground up to make the product used in dentifrices and perfumes.

Blue-eyed Grass (*Sisyrinchium*) is a small plant with flattened stems, stiff grass-like leaves, and small clusters of purplish-blue flowers with spreading segments. Eastern Blue-eyed Grass grows in meadows and fields from the Atlantic Coast to the Rocky Mountains. Western Blue-eyed Grass, found on wet grassy slopes in California, has blue flowers with a yellowish base. Golden-eyed Grass of the southern Sierras has yellow flowers with dark brown veins.

Celestial Lily (*Nemastylis*) is a plant of the Kansas prairies, ranging south to Tennessee and Texas, with narrow pleated leaves and pairs of pale blue flowers with rounded petals and sepals.

The genus *Gladiolus*—derived from the Latin word "gladius" meaning sword, in reference to the leaves—includes one hundred fifty species native to Africa, the Mediterranean region and western Asia. The large, showy flowers are borne in crowded spikes, each funnel-shaped flower with unequal segments, some of which form hoods or roofs over the throat of the flower. One of the commonly cultivated species has red or yellowish flowers, streaked with various colors; this was grown and marketed as early as 1841. Interest in these strikingly flowered plants resulted in the formation of the American Gladiolus Society in 1910.

Another familiar cultivated plant of the Iris family is the *Crocus*—whose name is the Greek term for saffron. They are stemless plants with small grass-like leaves and showy clusters of funnel-shaped flowers which stand erect; the perianth is made up of six equal segments. The flowers, which generally open only in the sunlight, bloom early in spring or in fall. The seventy-five species of the genus are all native to the Mediterranean and southwestern Asia. A commonly cultivated species has lilac-colored flowers striped with white or purple.

THE RUSH FAMILY

The members of the Rush Family (*Juncaceae*) are grass-like plants often confused with the various species of grasses or sedges; the three hundred cosmopolitan species of the family have wiry and tufted leaves, and inconspicuous flower clusters made up of small flowers with two similar whorls of brownish sepals and petals. The majority are dwellers in swamps and along lake margins. Our native representatives are chiefly those of the genus *Juncus*. The Rice Rush is found throughout the whole United States, its pliant and flattened leaves being often woven into matting for floor coverings; the flowers are small and greenish in color. The Black Rush is the common species of brackish marshes from New Jersey to Texas; its stems are stout and cylindrical, and the brownish flowers form a loose terminal cluster.



Iris is the Greek term for rainbow, appropriately suggesting the variety of colors of these elegantly designed flowers.

CHAPTER XLIII

Orchids



ORCHIDS have often been called the elite of the plant kingdom; certainly in their floral structure they represent one of the culminations of plant evolution. Their showy and uniquely constructed blossoms fascinate laymen and professional botanists alike. The restricted range and the rarity of occurrence of the temperate terrestrial species, the peculiar relationships of the Orchids and their germinating seedlings with root fungi, and the exotic appeal of the tropical epiphytic Orchids all contribute to make the Orchid Family (*Orchidaceae*) of outstanding interest. The number of species is variously estimated at from five to ten thousand, the majority of these being tropical and subtropical epiphytes growing on the branches and trunks of trees. The temperate species are terrestrial, and are found in all kinds of shaded habitats provided they are neither excessively dry nor cold. Orchids are particularly abundant in the mountainous and damp woods of South America, Central America, Mexico, Java and Ceylon. In Mexico Orchids are used symbolically by the natives, each one conveying its own particular sentiment; some are used at baptisms, marriages and funerals; others are offered at the shrines of the saints, by lovers to their mistresses and by survivors at the graves of loved ones. To Americans, Orchids represent the acme of extravagance in a flower which stands for supreme beauty and elegance.

Orchids are closely related to the Lilies, from whose type of flower the Orchid blossom has evolved, adapting itself in a highly effective manner for insect pollination. It is a remarkable coincidence that so many of the Orchid flowers have actually come to look like insects and their relatives, with spidery petals and sepals and variegated "bodies" which are the lips of the flower. The Orchid flower consists of three petals and three petal-like sepals; one of the "petals" has become differentiated into a conspicuous lip with the special function of secreting nectar and attracting insects. The three pistils are fused to form a central column. The intricacy of the Orchid flower, and how it has come into being, is well described as follows: * "And what has the Orchid done? Examine the flower of a Yellow Moccasin or a Purple-fringed Orchid. Where are the fifteen parts, the five alternate whorls of three that it bore in its lilyhood days of radial symmetry? As soon as it tilted on edge and became a face looking out for insect visitors its flower was divided into two equal halves, an upper

and a lower. . . . To perfect the flower for insect pollination the inner whorl of three stamens and the middle one of the outer whorl were incorporated with the style into a single fleshy body known as the column; the lateral pair of stamens in the outer whorl were converted into showy petals and made connate with the middle lobe of the corolla which stood between them; to make a landing stage for insects, a spiral twist was given to the ovary-pedicle at the ripe hour of the opening bloom, so that the column and perianth took a half turn; and the glorified mid-petal, originally in the upper half of the flower, was swung into position as the lip underneath the column; a nectar well was sunk at its inner end and the pollen bearing anthers and stigma at the top of the



ORCHIDACEAE

White Lady's Slipper, Showy Lady's Slipper and Ram's-head Lady's Slipper.

column stood over the nectary." A highly specialized pollinating device developed, consisting of the conversion of one of the stigmas into a glutinous beak provided with sticky discs; these are connected by elastic threads with the masses of pollen (pollinia) produced above it in the anthers. These sticky threads adhere to the head of an insect pushing its way to the nectary of the flowers and as the insect withdraws it carries the pollinia in this way to another flower.

The vegetative part of an Orchid plant consists of a short stem, often in the terrestrial species reaching just above the ground, producing one to a few large leaves which are often only basal. In the epiphytic species, the stems produce peculiar "pseudobulbs", frequently elongated in shape, which are reserve food reservoirs; from them grow stiff leathery leaves, often like those of the lily in shape. These air plants of the

Orchid Family have aerial roots which cling snakelike to the tree trunks, often being green and carrying on photosynthesis as well. In tropical forests Orchids form epiphytic gardens on the branches and in the crotches of trees, where they live on accumulated humus or abstract their nourishment entirely from the air. Even though many of the tropical species thus grow on other plants, none are parasites. The terrestrial Orchids are characterized by a peculiar type of symbiosis between the root tissues and filamentous fungi, known as mycorrhiza. Just what the importance of the fungi is to the Orchids (which are green and therefore capable of independent living) is not known for a certainty; yet without the symbiotic fungi the Orchids do not thrive. More important still is the value of these fungi to the germinating seeds. The seeds



ORCHIDACEAE

Showy Orchis, Large Round-leaved Orchid, Tall Leafy Green Orchid.

of Orchids are of microscopic size, and are difficult to germinate under cultivation; growing Orchids from seeds baffled growers for years until it was discovered that each tiny seedling would grow only when in association with the proper root fungus. So today greenhouses have rooms where Orchid seeds are germinated in sterilized jars, inoculated with the fungus of the species found associated with that particular Orchid—test tube babies of the plant world.

Orchid culture began in the British Isles about 1732 with species collected in the Bahamas by a famous collecting botanist, Peter Collinson. By 1800 some fifty exotic species were being satisfactorily cultivated and hybrids raised from seed. Collectors were soon exploring hitherto unknown regions in South America, Central America and the Pacific Islands for these intriguing plants. Rare specimens brought high prices, numerous species being sold for four and five hundred dollars a plant. The interest in Orchids spread to Belgium, France, Switzerland, Germany and this country. Today there is hardly a nation where one cannot find enthusiastic Orchid culturists.

Like other highly evolved groups such as the Grasses and Composites, the Orchids are divided into "tribes" on the basis of definite floral features. Most interesting to us are the Lady's Slipper Tribe, the Rein Orchid Tribe, the Bird's Nest Orchid Tribe and the Tree Orchid Tribe.

THE LADY'S SLIPPERS

The scientific name *Cypripedium* given to the Lady's Slippers by Linnacus in 1753 means literally "slipper of Venus"; and well describes the shape of the sac-like lip



ORCHIDACEAE

Purple-fringed Orchid, Broad-leaved Twayblade and Rose Pogonia.

of the flower. The twenty species are almost entirely North American and Asiatic in their distribution. They are all terrestrial plants with large oval leaves, sometimes basal and often marked by lengthwise pleats. The Moccasin Flower or Stemless Lady's Slipper is a common species found in coniferous woods and sphagnum bogs of our northeastern states, south to North Carolina. The flowering stalk rises from between two basal leaves, bearing at its tip a single fragrant flower with narrow purplish-green sepals, even narrower brown petals and a drooping pink sac-like lip with darker veins. Smallest of our native species is the Ram's-head Lady's Slipper with a six- to twelve-inch stem bearing several elliptical leaves and a solitary red and white flower hanging downwards like a gayly colored cap on a hook; sepals and petals are a purplish-brown. This is a rare species of cold swamps in the northeastern states. One of the sunshine-loving members of the genus is the Yellow or Golden Lady's Slipper, found in rich leaf mould in a transcontinental range from New England to Washington. The fragrant flowers have crimson and purple sepals, spirally twisted petals of the same color, and a golden-yellow egg-shaped lip. More southern and cen-

tral in its distribution than most of the species, the dainty White Lady's Slipper is a stiffly erect plant with sheathing elliptical leaves and solitary flowers with greenish-purple sepals and petals and a white lip striped on the interior with magenta. The Showy or Queen Lady's Slipper is the largest and most showy of all our native Orchids. It grows to be two or three feet in height in the swamps and mossy woods of New England southward to Missouri and Georgia. The stout stem bears ovate strongly-ribbed leaves and flowers with pure white sepals and petals, and a white or mauve lip rose-striped on its face and spotted with purple on the inside. Yellow or Downy Lady's Slipper is one to two feet in height, with large oval leaves and flowers consisting of yellow sepals, striped with purple, spirally twisted petals and a yellow lip. This species grows in rich woods from New England to Georgia and Nebraska. Although most of the Lady's Slippers are peculiar to northeastern United States, there are a few far western representatives of this tribe of Orchids. The California Lady's Slipper of the northern part of that state bears six to twelve small flowers on each plant, yellowish-green with a white lip; while another species, ranging north to Washington, has a dull white lip veined with purple.

THE REIN ORCHID TRIBE

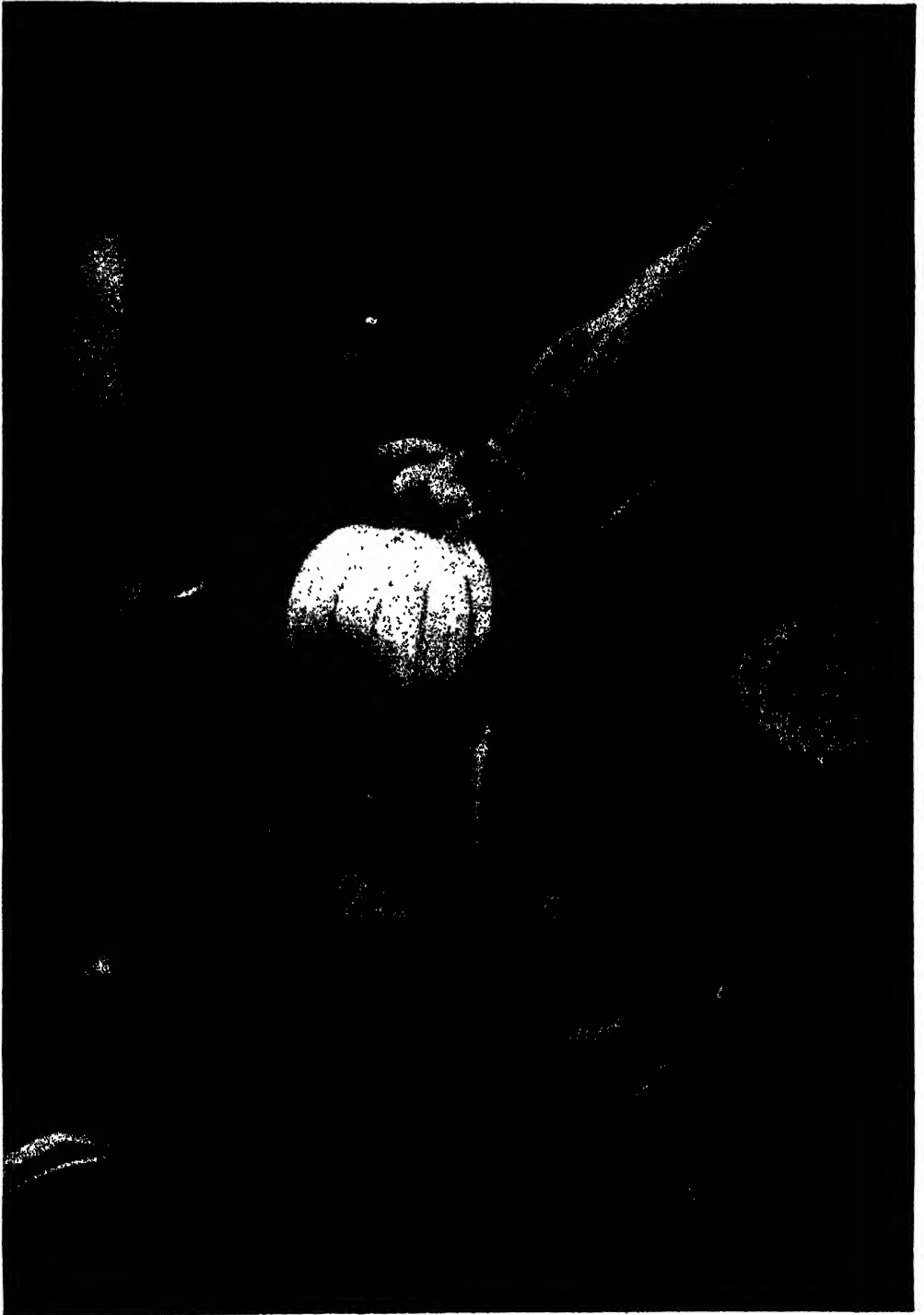
In the Rein Orchid Tribe the lip of the flower is prolonged into a spur or sac, and often the margin of the lip is lobed or delicately fringed. Here we find the Small Round-leaved Orchis, the Showy Orchis, Satyr Orchid, the Large Round-leaved Orchid, the Tall Leafy Orchids, the Fringe Orchids and the Rein Orchids.

The Small Round-leaved Orchis (*Orchis*) is one of the few members of the family which prefer northern climates, ranging from Greenland and British Columbia to a few recorded stations in cedar and tamarack bogs of New York, New England and the north central states. The flowering stalk which is less than a foot high has at its base a solitary rounded leaf and is terminated by a cluster of three to twelve small flowers. Each flower has rose-colored petals and sepals and a three-lobed white lip, spotted with purple. The Showy Orchis (*Galeorchis*), a stouter plant with rather fleshy stem and a pair of basal leaves, is found in rich deciduous woods from New England to North Carolina and Nebraska. Three to eight elegant flowers are borne on a short flowering stalk, the violet-purple sepals united to form a hood over the petals, the white tongue-shaped lip prolonged into an obtuse spur.

The Satyr Orchid (*Cocloglossum*) is a plant of wet meadows and woodlands from the Blue Ridge Mountains west to Nebraska and Washington; the leafy stems bear terminal spikes of small flowers with converging greenish sepals and petals, and with a narrow short-spurred lip.

The Large Round-leaved Orchid (*Lysias*), one of six north temperate species, has a stout flowering stalk one to two feet tall rising amid two large round basal leaves; the flowers, each with greenish-white spreading sepals, narrow petals and an entire long-spurred lip, are borne in a loose terminal cluster. It is found in woods from New England to Pennsylvania and Minnesota.

The Tall Leafy Green Orchid (*Limnorchis*) has a stout stem up to three feet in height, bearing narrow oblong leaves which farther up the stem become small bracts, and inconspicuous yellowish-green flowers crowded into a terminal spike. The sepals and petals are spreading, the lip entire and spurred. This species, found in bogs and



The Lady's Slippers (*Cypripedium*) are among our most exquisite native Orchids, the lip of the flower being fashioned into an inflated sac. Hamilton, New York. Photograph by O. B. Stanley.

wet woods from the northeastern states to Oregon, is one of the commonest Orchids in the Northern Hemisphere. The Tall Leafy White Orchid, known also as the Fragrant White Bog Orchid, is a more slender and small plant with waxy white clove-scented flowers, living in bogs and wet woods from northern New England and New York to the Pacific coast.

The Fringe Orchids (*Blephariglottis*) are familiar members of the Orchid Family, with leafy stems and terminal spikes of flowers in varying colors, characterized by delicately fringed lips; there are about ten species, all North American. The Crested or Golden-fringed Orchid, which grows to a height of several feet, has narrow clasping leaves and a crowded spike of bright orange flowers with incurved petals and sepals, the petals being fringed as well as the lip. The spur of this Orchid is slender and straight. This is a southern species, common to the pinelands from Tennessee to Louisiana. The Yellow-fringed Orchid is a slightly larger plant with pointed elliptical leaves and a crowded spike of orange-colored flowers whose petals are toothed and lip-fringed; this is the only orange-colored Orchid native to the northern states, being found on grassy and sandy wood margins from New England to Texas and Michigan. The White-fringed Orchid is a plant of similar appearance, except for the color of the flowers which form a feathery terminal spike; it inhabits bogs and swamps from New England to Minnesota and Florida. The Prairie White-fringed Orchid, with larger fragrant blossoms which are often tinged with green, is rare east of the Appalachian Mountains, common in the Mississippi valley; it has the most western range of the Fringed Orchids. The Ragged or Green-fringed Orchid, like most of its relatives, grows to be only one or two feet tall; the pale yellowish-green flowers are borne in a loose spike. Being inconspicuous and not particularly beautiful, this common Orchid of the wet meadows of our eastern states is often overlooked. The lip is divided into three copiously fringed segments, each with a narrow basal portion. The Small Purple-fringed Orchid, also known as the Fairy Fringe, is a slender plant growing to a height of three feet, with narrow tapering leaves and a spike of lilac-purple, very fragrant flowers, with toothed petals and fringed three-parted lip. It is found in wet meadows and swamplands from New England to North Carolina and Minnesota. The Large Purple-fringed Orchid, found in similar locations, is recognized by its larger flowers.

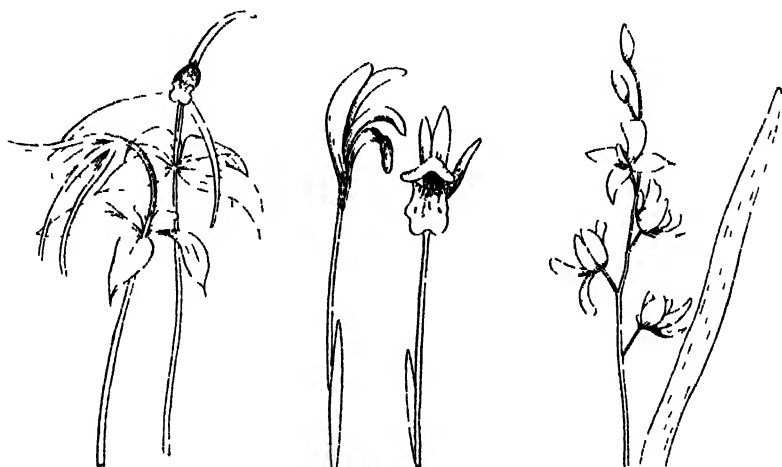
The Rein Orchids (*Habenaria*) include about fifty species which are most abundant in the tropics; the flowers—white, green, or yellow in color—are borne in a loose spike, with spreading sepals, unequally two-parted petals and a spurred lip divided into three segments. The Long-spurred Rein Orchid of ditches, swamps and lake shores from North Carolina to Louisiana is often found floating in detached masses among Water Hyacinths and Water Lettuce. The leaves are narrow and tapering and the flowers are characterized by having the lateral lobes of the lip longer than the middle one, and entire. Seven species occur along the Pacific Coast, of which the Sierra Rein Orchid grows in moist places from the Sierras to Utah and Alaska. Another genus (*Gymnadeniopsis*), includes other plants also known as Rein Orchids; the White Rein Orchid with white or pink flowers inhabits low pinelands and meadows from New Jersey along the coastal plain to Texas. The Green Rein Orchid, with greenish-yellow flowers, ranges in moist place from New England to the Mississippi valley.



The Vanilla Orchid (*Vanilla*) is a climbing vine of the tropics. McKee Gardens, Vero Beach, Florida.

broadly triangular lip is bearded with yellow orange and rose-colored hairs. Its home is in bogs and meadows of our eastern states.

Ladies' Tresses or Pearl Twists (*Ibidium*) constitute a fairly large genus of some eighty species of temperate and tropical American Orchids, they are distinguished by the spiral arrangement of the flowers in a narrow dense spike. Wide-leaved Ladies' Tresses is an inconspicuous little Orchid less than ten inches tall, with a basal cluster of five or less lanceolate leaves, the small flowers have white sepals and petals, and a pale yellow lip with a crisped or fringed margin. It prefers moist meadows, ranging from New England to Virginia and Minnesota. Nodding Ladies' Tresses is a larger



ORCHIDACEAE

Whorled Pogonia, Wild Pink and Grass Pink

and more showy species found in moist pastures and springy hillsides of the northeastern states, its flowers, fragrant and white or yellow with a wide lip, are borne in a terminal spike. Several species range westward to the Pacific Coast. Largest of all is the Giant Ladies' Tresses which reaches a height of thirty inches in the grassy bogs of the coastal plain from New Jersey to Florida, the leaves are basal and grass-like, the flowers a snowy white.

The Rattlesnake Plantains (*Epipactis*) are leafy-stemmed Orchids with small greenish-white flowers in terminal spikes, without the spiral arrangement of the blossoms. Downy Rattlesnake Plantain, which grows to a height of twenty inches, has a cluster of basal leaves which are bluish-green marked with white along the veins, the white flowers, sometimes tinged with green, have the upper sepals united with the petals to form a hood over the bulging sac-like lip. It is one of the few Orchids found in dry woods, ranging from New England to Florida and Minnesota. The Stream Orchid of moist stream banks of the Pacific Coast states is another species of this genus, with ovate lower leaves and loose clusters of purplish-green flowers.

The only Orchid of any economic importance belongs to this tribe of the Bird's Nest Orchids. The *Vanilla* plant (*Vanilla*) is a vine with a rope-like stem, attaching

itself to the trunks of trees by aerial roots; the leaves are broad and elliptical. Pale-colored flowers with narrow sepals and petals, and a fringed lip curling up to form a cornucopia-shaped structure, are borne in axillary clusters. The elongated fruit capsule is the vanilla bean of commerce. Vanilla, a native of Mexico, requires a hot damp climate; it is cultivated profitably only in the West Indies, Java, Mauritius and other tropical islands. Together with other species of the genus, Vanilla is often found as an escape in the Florida hammocks. Vanilla vines are trained against posts or trees, a single vine bearing as many as fifty pods a season; the unripe pods are picked and dried, the vanillin crystallizing on the outside of the capsule.



ORCHIDACEAE

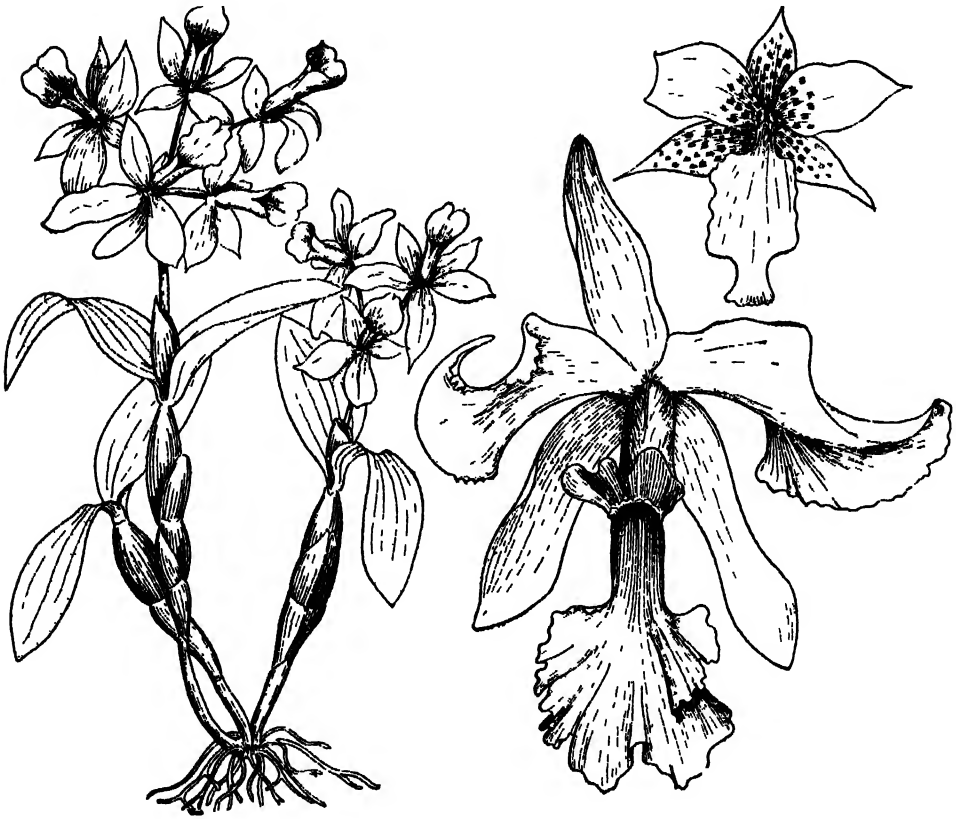
Calypso, Crane-fly Orchid and Putty-root

THE TREE ORCHIDS

The Tree Orchid Tribe includes but a few terrestrial members, such as the Adder's Mouths, Twayblades, Calypso, Crane-fly Orchid and Putty-root; the great majority are epiphytes of warmer regions, some of them cultivated and sold as the Orchids of the florist's trade. The only epiphytic native species is the Greenfly Orchid; an introduced plant found in eastern Florida is the Cowhorn Orchid. Florist's Orchids include the Cattleyas and Dendrobiums.

The Adder's Mouths (*Malaxis*) have elongated sheathing leaves and terminal clusters of flowers with thread-like petals, shorter than the sepals, and a broad-lobed lip. White Adder's Mouth is a slender plant with a single sheathing leaf, broadened into an elliptical blade; the flowers are small and white. This Orchid grows in woods from New England to Pennsylvania and Nebraska. Green Adder's Mouth has a single ovate leaf clasping the middle portion of the stem, and greenish flowers whose projecting sepals and three-toothed lip suggest the jaws of a snake with exposed fangs; it is a plant of woods and hillsides throughout the northeastern states. Western Adder's Mouth, found from the Pacific Coast eastward to Texas and Minnesota, has more pointed sepals than the other species.

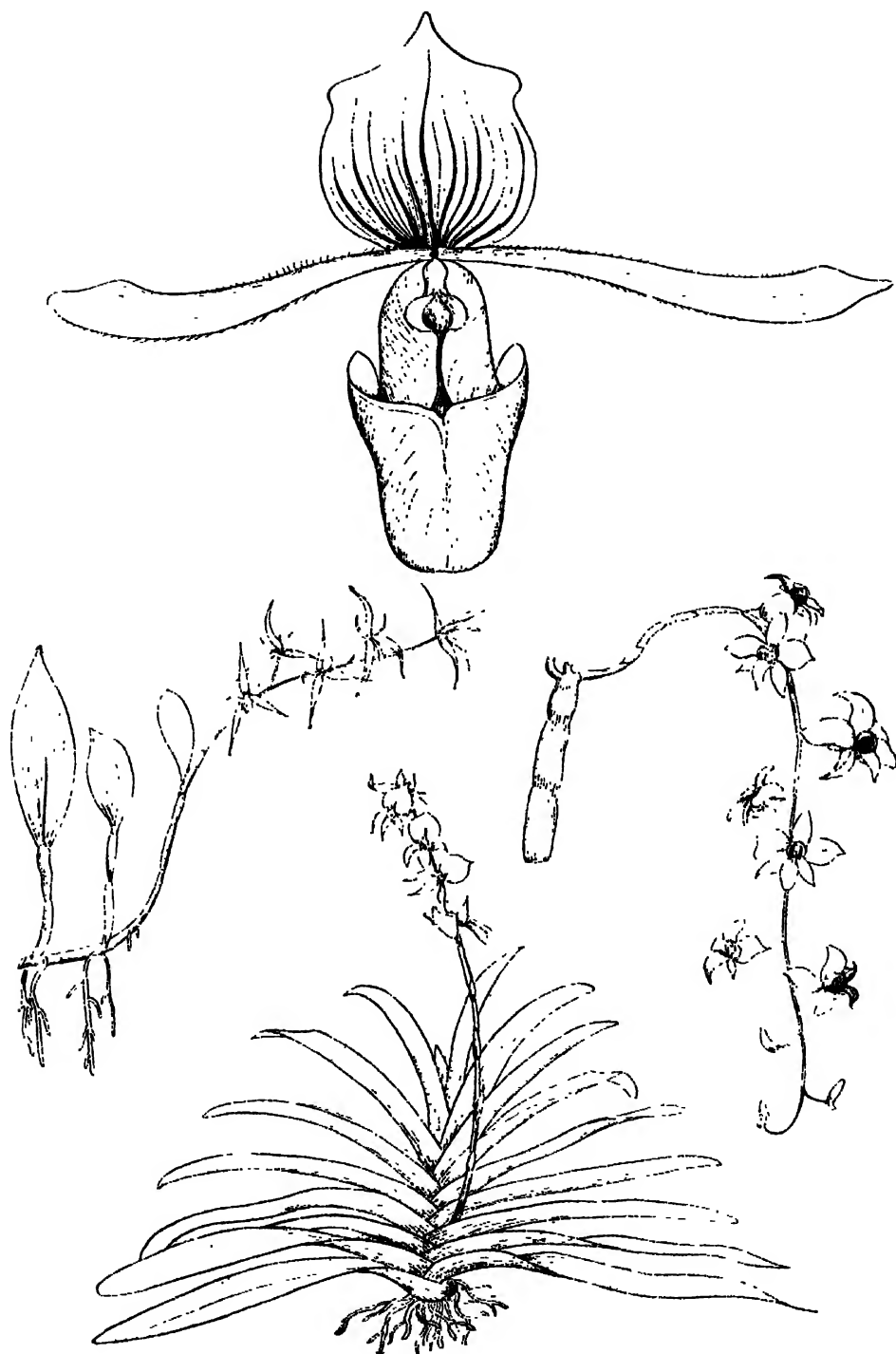
The Twayblades (*Liparis*) have two or more large leaves at the base of the flowering stalk and a terminal cluster of flowers with thread-like petals which are longer than the sepals and a dilated lip. Large Twayblade is a sleek stout plant with a loose spike of six to twenty yellow flowers marked with green and purple, it ranges from New England south to Georgia and west to Missouri. The Fen Orchis found in grassy boglands over approximately the same range has a loose cluster of yellow flowers, each with an incurved lip slightly shorter than the petals and sepals.



ORCHIDACEAE

Cattleya plant and blossom, *Odontoglossum* (upper right)

Calypso (*Calypso*), named after Homer's island nymph, is one of the rarest and most beautiful of the terrestrial Orchids, resembling a small Lady's Slipper. This elusive plant hides in the deep recesses of Arbor Vitae or spruce woods and swamps of the northern portions of the Atlantic and Pacific Coasts. It is a small plant, hardly six inches in height, with a single rounded basal leaf and a showy solitary flower variegated with purple, pink and yellow. The ascending wavy petals and sepals suggest the outstretched fingers of a hand, beneath is the lip forming an apron of delicate texture "half transparent, the ground color whitish tinged with rose, the upper part

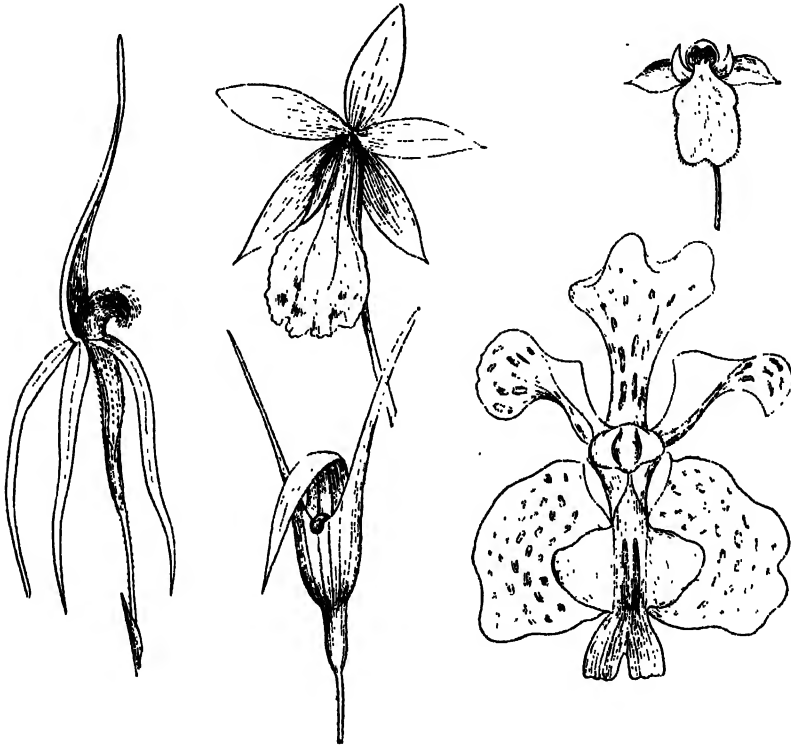


ORCHIDACEAE

A North Borneo *Cypripedium*, *Epidendrum* (lower left), *Angraecum* (lower center) and *Dendrobium* (lower right).

daintily spotted with flecks of rich purple and crested with a beard of glistening yellow hairs like spun glass."

The Crane-fly Orchid (*Tipularia*) is well named, looking like some slender-winged insect alighting upon a green stalk. The brownish sepals and petals are narrow and spreading, all but fluttering in their resemblance to a dragon fly; the lip is purplish-green, three-lobed and projecting into a long slender spur. There is a single basal leaf. This Orchid is found in moist woods of the Gulf states, north to New Jersey and Ohio.



ORCHIDACEAE

Flower variation among the tropical Orchids. *Caladenia*, *Pleione* (upper center), *Pterostylis* (lower center), *Ophrys* (upper right), *Landa* (lower right).

Putty-root (*Aplectrum*), found in deciduous woods from Georgia to Arkansas, occasionally farther north and east, produces a single basal leaf which disappears before the flowering stalk produces its small cluster of brownish-yellow blooms, striped with purple and with a spur-less lip.

The unique distinction of being one of our few native epiphytic Orchids falls to the Greenfly Orchid (*Epidendrum*), found on branches of trees from North Carolina to Louisiana and Florida. The tufted stems bear spreading elliptical leaves and slender flowering stalks with open clusters of fragrant flowers—green and purple with a broad spurless lip. Occasionally found naturalized on sand dunes along the

CHAPTER XLIV

Aquatic Seed Plants



AS LAND-DWELLERS ourselves, we naturally think of plants in terms of their terrestrial representatives—the flowers, shrubs and trees which make up the land flora. However, as we have seen in previous chapters, there exist in the lakes and oceans many simple plants which show us what the first forms of life may have been like long ago while all plants were water-dwellers and before the migration of some to the land. These simple plants, the Green, Brown and Red Algae, are still the most completely adapted water plants; for this reason they are the dominant forms of vegetation in both salt and fresh waters. But in the succeeding groups of higher plants, which have spent millions of years in adapting themselves to a terrestrial life, there are at the same time many genera and families which have reverted to an aquatic habit of living; returning, so to speak, to the ancestral environment which originally gave them birth. In this backward march to the water, few of the higher plants have been able to fit themselves for life in the salt water of oceans, therefore one finds very few Seed Plants living actually in salt water. But it is a different story with those of fresh water streams, ponds and lakes. Here we find such aquatic Bryophytes as *Fontinalis* as well as the generally amphibious Liverworts; and such water-dwelling Pteridophytes as Pepperwort, Floating Fern and Floating Moss. Among the Spermatophytes, various families discussed in previous chapters have representatives living in or on the water; notable examples are the Cypresses and Mangroves, the Rushes and Sedges, Water Cress, Bladderwort, various Aroids and the Duckweeds.

In this chapter our interest centers in those families which have more completely adapted themselves as water-dwellers. Such aquatic plants inherit a body plan involving roots, stems, leaves and complex reproductive organs which include flowers. When these plants adopt the water as their home, modification of certain structures and functions must take place. Woody supporting tissues are not necessary in the stems; so this part of an aquatic plant becomes light and porous, the natural buoyancy of the water supporting vegetative organs. Roots are absent or used chiefly as anchoring organs, the dissolved minerals in the water often diffusing into the plant tissues through the stems or leaves. The leaves often undergo some modification, those under water becoming subdivided and dissected into thread-like segments like the filaments of Green Algae. Above-water leaves remain, for the most part, unchanged; though some become rounded floating pads on elongated stems. The flowers are usually produced above

water; but in some species the flowers begin their growth under water, and when mature rise to the surface in order that pollination may take place. Most aquatic plants with the latter habit have inconspicuous flowers.

Many of the aquatic flowering plants are of interest because of their value in aquaria and in that fascinating phase of plant culture, water gardens. Most of the aquatics belong to the Monocot group—the Cat-tail, Bur-reed, Pondweed, Arrow-head, Frog's-bit, Pipewort and Pickerel Weed Families.

AQUATIC MONOCOTS

The Cat-tail Family (*Typhaceae*) is a small one, with but a single genus and a dozen species, temperate and tropical in their range. The common Cat-tail (*Typha*) which



SPARGANIACEAE AND POTAMOGETONACEAE

Bur-reed; Pondweed and Ditch Grass.

forms the familiar dense growths, six to eight feet high, along the shores of ponds and streams as well as in swamps, ranges throughout the United States. The stiff stems bear erect narrow leaves which taper to a slender tip, often arching gracefully. Minute flowers, lacking petals and sepals, and having a perianth of small bristles, are crowded into a brown plush-like cylindrical structure at the top of each stem. Fluffy hairs like those of a thistle aid in wind dispersal of the tiny nut-like fruits. In some localities the leaves are used in the manufacture of matting, and the fluffy fruits for stuffing pillows and mattresses.

The Bur-reed Family (*Sparganiaceae*) is closely related to the Cat-tails; it too is a small family of but a single genus, with about two dozen species distributed throughout the United States. The erect leaves, in general appearance like those of an *Iris*, are either triangular and keeled or flat and floating. The flowers, lacking sepals and petals, and with a perianth of small scales, are borne in globular heads.

The preceding two families prefer to have their roots and parts of their stems in the water, but their leaves above the surface. In the Pondweed Family (*Potamogetona-*

ceae) the stems and leaves are often entirely submerged. This family includes about eighty species native to temperate regions. Pondweed (*Potamogeton*) occurs in ponds and streams throughout the United States, often in such quantities as to obstruct navigation. When its leaves float upon the surface of the water, they are broad and ovate; but when submerged, they are thread-like and more delicately-constructed. The small and inconspicuous flowers occur in clusters on a fleshy spike, above the water; there are four rounded sepals to each flower. The Pondweed Family also includes two marine plants, mistaken for grasses by the average observer. Ditch Grass (*Ruppia*) has long thread-like forking stems and narrow grass-like leaves which form waving masses beneath the surface of the water; it is common in brackish estuaries and along the sea-



ALISMACEAE, ERIOCALACEAE AND PONTEDERIACEAE

Arrowhead, Pipewort, Water Hyacinth.

coasts of both the Atlantic and Pacific Ocean. The flowers are produced in spikes, under water, lacking petals and sepals; when mature the flowers rise to the surface and open. Fel Grass (*Zostera*) is another submerged grass-like plant of brackish and salt waters everywhere, long ribbon-like leaves growing from the creeping jointed root-stock. The naked flowers are borne in rows on a leaf-like spadix, hidden in a leaf sheath.

The Arrowhead Family (*Alismaceae*) includes less than a hundred species common to freshwater swamps and lakes. The leaves are large and basal, produced above the water; the flowers, with both petals and sepals, are borne in whorls on long flower stalks. Water Plantain (*Alisma*), found in swamps and ditches from New England to Florida and Texas, has elliptical or oval leaves and tall branched flowering stalks bearing whorls of small flowers with white-margined sepals and white petals with yellow narrowed basal portions. Arrowhead (*Sagittaria*) is so-named because of the pro-

jecting posterior lobes of the large leaves, which resemble spear or arrow heads, the long-stemmed leaves project out of the water, surrounding the stout flowering stalks with their white flowers, produced in threes, and made up of three sepals and three petals. This is an attractive marsh plant, often used in the margins of lily pools and water gardens. Some two dozen species occur throughout the United States. Also known as Swamp Potato or Fule Potato, this plant has edible tubers which were eaten by the Florida Indians, the Chinese, who also eat the tubers, are responsible for its introduction into southern California.

The Frog's-bit Family (*Hydrocharitaceae*) includes several common aquarium plants among the fifty species found throughout the world. They are all submerged aquatics with small or dissected leaves. Tape Grass (*Elodea*) grows in streams



HYDROCHARITACEAE

Tape Grass, Water Weed and Frog's-bit

and lakes of Florida and Louisiana, where it is the favorite food of ducks and other aquatic birds. The slender ribbon-like leaves form compact spiral clusters on short stems. The small flowers have an inconspicuously colored three-lobed calyx and three small petals. As an adaptation to secure pollination, the cluster of male flowers, produced under water, floats to the surface and comes in contact there with the female flowers, which likewise have come to the surface through rapid elongation of the flowering stalk. Tape Grass is commonly used in aquaria, being planted along the bottom where it forms gracefully ascending grass-like growths. Water Weed (*Elodea*), also used in aquaria, has an elongated floating stem covered with small moss-like leaves, opposite or in whorls, the minute male flowers behave as in Tape Grass, rising to the surface to pollinate the female flowers which are raised on a prolongation of the calyx tube. Water Weed is common in ponds, streams and springs throughout the United States, often choking stagnant waters with its luxuriant growth. Frog's-bit (*Linnobium*), found in stagnant water from New Jersey to Texas and Florida, has heart-shaped or rounded leaves, often colored purplish-green on the undersurface. The



Cat-tails (*Typha latifolia*) produce thousands of minute flowers and seeds in brown and velvety cylindrical structures. Brooksville, Maine.

small flowers have a three-parted calyx and three petals. When ponds dry up, Frog's-bit frequently remains to cover the muddy bottom with a sordid growth of bright green.

The Pipewort Family (*Eriocaulaceae*) is larger than most of the aquatic families, with five hundred species, but most of these are found only in South America. They are water and marsh plants with creeping rootstocks and clustered narrow leaves. Pipewort (*Eriocaulon*) is a stemless or short-stemmed submerged plant with a cluster of grass-like leaves and long stiff flowering stalks which project above the surface of the water, the small heads of minute whitish flowers, each with several sepals and a tubular three-lobed corolla, look like little buttons on tops of slender stalks.

The Pickerel Weed Family (*Pontederiaceae*) is a small one, consisting of a few



HALORRHAGACEAE, CERATOPHYLLACEAE AND CABOMBACEAE

Water Milfoil, Hornwort, Water Shield and Purple Bonnet

dozen showy-flowered plants of swamps and ponds. Pickerel Weed (*Pontederia*), found from New England to Florida and Oklahoma, has large glossy green leaves with heart-shaped base, and erect flowering stalks bearing terminal compact spikes of small blue flowers, each flower is two-lipped, each lip being divided into three lobes. Water Hyacinth (*Eichhornia*) is a South American genus commonly cultivated in lily pools and water gardens, it is a floating plant, with pendulous roots hanging downward into the water, and with peculiar rounded leaves characterized by inflated and pitcher-like petioles which act as buoys and keep the plant afloat. The blossoms are so beautiful that they have been called Water Orchids, the funnel-shaped flowers, six-lobed and pale violet, lilac or white, are borne in small clusters. It is known as the "million dollar weed" in Florida, where it has formed such luxuriant growths that it is a costly matter to keep the St. John's River open to navigation.

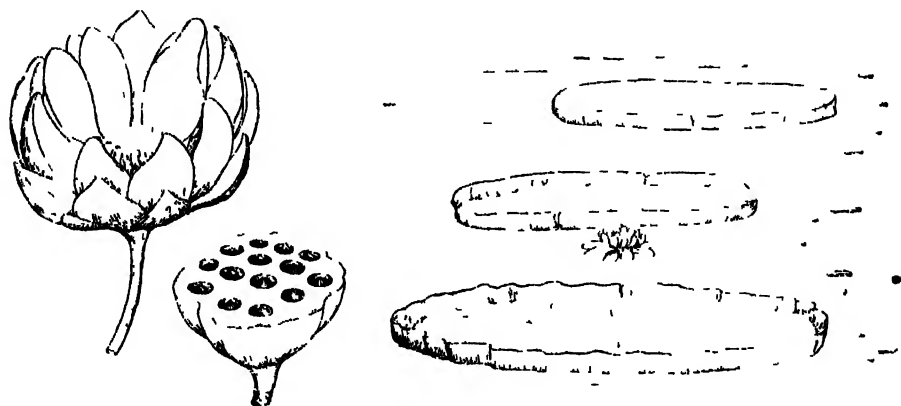
AQUATIC DICOTS

Aquatic families are found among various orders of the Dicot group, several of them with inconspicuous flowers and others with flowers which rank among the most beau-



Pickerel Weed (*Pontederia cordata*) is an aquatic with terminal spikes of blue flowers. Brooksville, Maine.

tiful in the world. The Water Milfoil Family (*Halorrhagaceae*), related to the Evening Primroses and Myrtles, includes a hundred species of widely distributed amphibious and aquatic plants. Water Milfoil (*Myriophyllum*), usually a submerged plant, is sometimes found creeping on the mud; the long floating stems bear compact whorls of delicately subdivided leaves which give a bottle-brush aspect to the plant. Small flowers with a four-parted calyx and four petals are found in the upper leaf axils, usually produced above water. Water Milfoil, like Tape Grass and Water Weed, is a favorite aquarium plant. The Hornwort Family (*Ceratophyllaceae*) includes the single genus Hornwort (*Ceratophyllum*), common to slow streams and ponds from Florida to California and northward. It grows under water, producing three-forked leaves divided



NELUMBONACEAE AND NYMPHAEACEAE

American Lotus, Royal Water Lily

into narrow rigid segments. The flowers minute and axillary without petals or sepals indicate a relationship with the families of the Buttercup Order.

The other families of aquatic Dicots have more attractive and showy flowers; they are all closely related to the Buttercups and Magnolias, and are classified with them in the Buttercup Order. Most of the species root in the mud of shallow ponds and slow streams, and produce floating leaves on long sinuous stems, or aerial leaves borne above the water on stiff stems.

The Water Shield Family (*Cabombaceae*), with less than half a dozen species, includes the Water Shield (*Cabomba*) found in streams and lakes from North Carolina to Texas. The stems, often coated with a transparent jelly, are frequently tinged with purple or red; the submerged leaves are subdivided into thread-like segments while the floating leaves are shield-shaped. White or pink flowers float on the surface, with three or four sepals and a similar number of petals of the same size. Purple Bonnet (*Brasenia*), found in still waters from Florida to Texas and northwards, lacks the subdivided submerged leaves but has similar floating ones; the flowers have a dull purple perianth of linear sepals and petals.

The Lotus Family (*Nelumbonaceae*) includes only three species, one native to the



Water Hyacinth (*Eichhornia crassipes*) is a floating aquatic that often blocks navigation in rivers of our southern states. Everglades, Florida

United States, the others to the Old World. American Lotus or Duck Acorn (*Nelumbo*) grows in two to six feet of water, from New England to Nebraska and Texas. The rounded leaves are attached to the stems by the center of their under surface, and are often supported stiffly above the water. The large fragrant flowers, solitary on erect flowering stalks, are a pale yellow, with the pistillate portion forming a peculiar inverted-conical, flat-topped structure pitted with holes in which the acorn-like fruits are embedded. These fruits were used as food by the Indians of the Tennessee and Cumberland River regions, over four hundred years ago, and the plant was undoubtedly spread as far north as its present range (to Connecticut) by them. The Indian Lotus or Sacred Bean found in Japan, the Philippines, India and northern Australia



NEUMBRONACEAE AND NYMPHAEACEAE

Indian Lotus (center), Yellow Pond Lily (left) and White Water Lily (right)

is frequently cultivated in water gardens because of the bold and artistic effects of the foliage and the white, pink or red flowers. None of the Lotus species is the "lotus" of the Egyptians or of the "lotus-eaters" of antiquity. The Egyptian lotus was a species of *Nymphaea*, while the plant of Tennyson's poem, prized by the Lotus-eaters, may have been a prickly African shrub (*Zizyphus*) which has olive-like fruit, with the sweetness of honey and the taste of a date.

The Water Lily Family (*Nymphaeaceae*) includes about fifty species of aquatics with floating leaves and showy flowers, natives of the north temperate zone and commonly cultivated in "lily ponds" and water gardens. A stout horizontal rootstock, rooting in the mud, bears long-stemmed rounded leaves with a deep notch at the base where the stem is attached. Yellow Pond Lily or Spatterdock (*Nymphaea*) has globular flowers made up of six sepals and numerous small scale-like petals borne with the stamens beneath the ovary; a yellowish-red flattened disc is spread out above the center of the flower, covering the pistils. The berry-like fruit matures above the water. This small but common member of the family is found in ponds and slow streams from

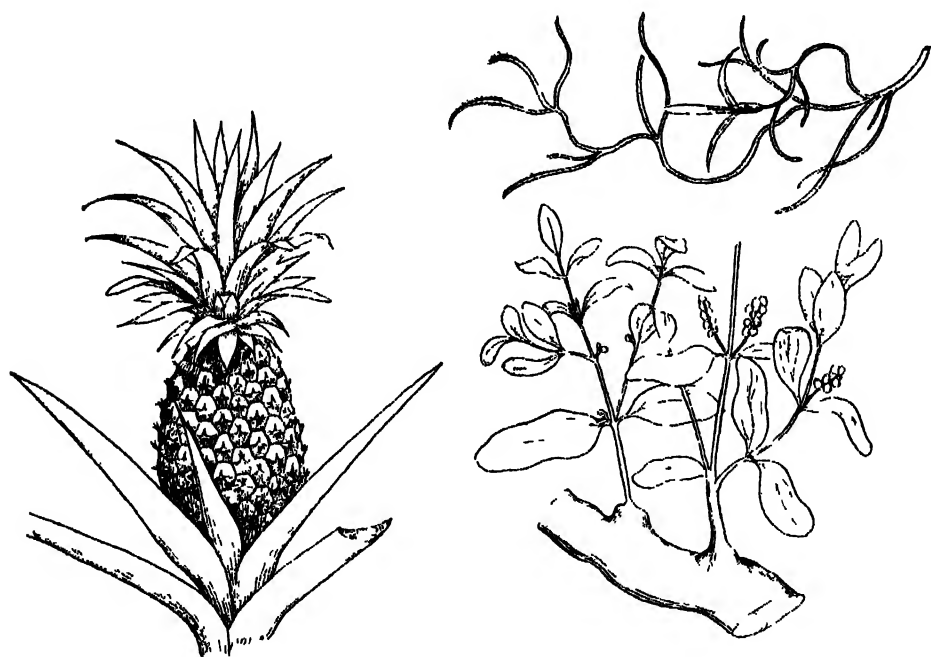
Plant Epiphytes, Parasites and Saprophytes

THE green color of the plant kingdom is, as we have seen, the symbol of their independence over all other living things; with this chlorophyll the plant protoplasm can live in supreme indifference to all other forms of life, securing the necessary foods for its sustenance from sunlight, air, water and the inorganic minerals dissolved in it. But, even so, as plant evolution has taken place, various types of dependence upon other plants and animals has arisen; just why, no one knows. Perhaps an inherent weakness, resulting from an accident in the transmission of the genes from one generation to the next, resulted in the plant's depending on a more fortunate neighbor for some sort of assistance. Actual loss of chlorophyll has been the most critical of such "accidents"; the plant eventually becoming dependent upon some source of organic materials. Even some chlorophyll-bearing plants show an interesting type of dependence. Such are the climbing vines, especially abundant in the tropics where the premium is on reaching the light, high up above the roof of the jungle floor; wasting no time in developing strong woody tissues as do the trees, they twine themselves about the slower-growing trees and push their way upwards until their leaves reach the gladdening sunlight. Often such climbers do not injure their obliging plant relatives, since their roots are in the soil, and they are entirely self-supporting except for the habit of using a robust woody plant as a stepladder to the light. Numerous climbers are found also among our native species; some of these have been mentioned in previous chapters.

Then there are the green plants who have severed all connection with the earth. These are the true epiphytes or air plants, self sustaining in their manufacture of food and absorption of nutriment by their aerial roots, but using other plants as a substratum on which to grow. Epiphytes are not injurious unless they grow in such profusion as to cut off light from the leaves of the "host" or to overburden its branches by their combined weight. We have already met several kinds of epiphytes in foregoing chapters: the minute green *Protococcus* which forms a green coating on the bark of trees, the Scale Mosses and True Mosses and Liverworts which clothe living trees as well as prostrate trunks with a mantle of green, and the host of such Pteridophytes as the Resurrection Fern of the southern states which forms aerial gardens on the sloping trunks of venerable Live Oaks. Of the Spermatophytes, we have noted the epiphytic habit of young Banyan trees, and its prevalence among the tropical Orchids. The best

example of completely adapted epiphytic habit, however is found in the Pineapple Family

The Pineapple Family (*Bromeliaceae*) is a Monocot group closely related to the Pickered Weeds, and classified with them in the order *Xyridales*, there are some nine hundred species which are chiefly tropical and subtropical American plants. The majority are epiphytic in habit the exception being the Pineapple (*Ananas*) which gives the family its name. Pineapple plants grow to a height of two to four feet with a stout stem clothed with long Agave-like leaves at the top of the stem is produced the peculiar cone-like fruit (whence its name *pine* apple) which is the result of the fusion of



BROMELIACEAE AND LORANTHACEAE

Pineapple, Florida Moss (upper right) Mistletoe growing out of branch of host plant

all the sepals, petals and ovaries of the flower cluster with the fleshy axis. Fertile seeds are rarely formed, propagation under cultivation being by cuttings. A crowded rosette of stiff sharply pointed leaves is produced at the top of the fruit. Pineapples were grown by the natives of Mexico and Peru before the appearance of the Spaniards, who carried them to the Indies, Asia and Africa. Today our fresh pineapples come from plantations in Porto Rico and Cuba, a few from the southern tip of Florida where pineapple culture was attempted as early as 1860. Most of the canned pineapple comes from the Hawaiian Islands.

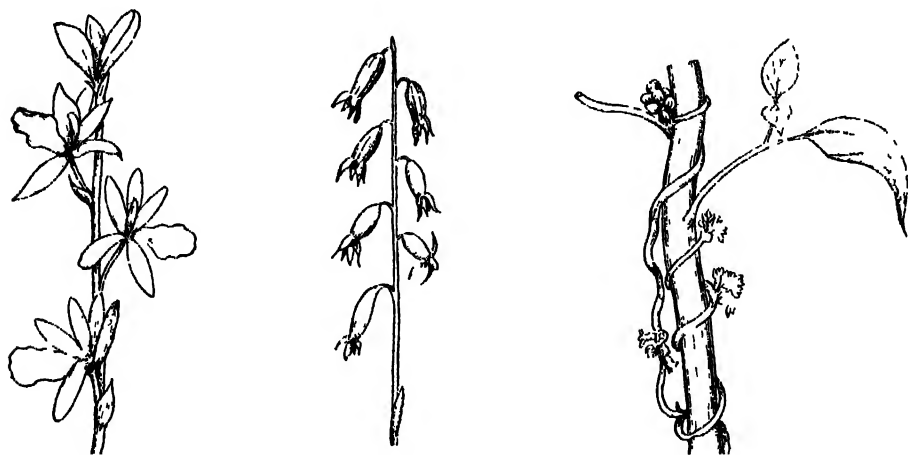
Florida Moss (*Tillandsia*) is one of the commonest members of the Pineapple Family, and is perhaps the most abundant epiphyte in the United States. This picturesque plant forms gray-green festoons on the trees of our southeastern states, being es-



Florida Moss (*Tillandsia usneoides*) decorates Live Oaks, Cabbage Palms and other trees in our southeastern states with streamers of gray-green. Highlands Hammock State Park, Sebring, Florida.

pecially abundant on Cypresses and Live Oaks from Virginia to Texas. In general appearance and habit it suggests the Old Man's Beard of the northern states. Florida Moss is the most characteristic feature of the coastal plain swamps, often completely covering the trees with drapery of thread-like stems and leaves. The long slender leaves, hardly different from the stems, are like them covered with silvery gray scales, the yellowish-brown flowers with long narrow sepals and petals are easily overlooked. In many parts of the South this epiphyte has become a weed, encroaching upon citrus groves, lawn trees and telephone wires. The apparent lack of leaves and flowers is responsible for its popular misconception as a moss.

Closely related to Florida Moss are the various species of Air Pines (*Tillandsia*)



ORCHIDACEAE AND CONVULVACEAE

Brunelia, Coral Root. Dodder twining about host plant.

found in Georgia and Florida. They have over three hundred relatives in the tropics. The Air Pines have stiff leaves in a compact rosette, sometimes quill like and in other species resembling those of an *Alloe* or *Agave*. In color they vary from a gray-green to a violet or reddish-tinted green. Elongated flowering stems bear clusters of violet, rose, cream or white flowers with three sepals and three petals and colored bracts. So numerous do the colonies of these little stiff-leaved epiphytes become that the accumulation of rain water at the base of their leaves is often weight sufficient to break the limbs of century old Live Oaks. In some instances Air Pines have colonized even the telephone wires, forming bird-like tufts on this most recent of all supports for epiphytes. A tropical American relative *Billbergia* with large Pineapple-like leaves which are often variegated in color, is frequently cultivated because of its unique habit and showy green or purple flowers with three long petals and protruding stamens.

An interesting transition from the epiphytic to the parasitic mode of living is exemplified by the Mistletoe Family (*Loranthaceae*), a relative of the Peppers and Buckwheats, and grouped with them in the *Monochlamydeae* group of the Dicotyledons. Like the epiphytes, members of this family have chlorophyll and manufacture their



Air Pines (*Tillandsia*) are common epiphytes in Florida and adjacent states. Merritt Island, Florida.

own food but instead of having aerial roots which serve only to anchor the plant, the Mistletoes have specialized rootlets (haustoria) which reach into the conducting tissues of the host and get their water supply in this way. Mistletoe (*Phoradendron*) is a shrubby plant with fleshy stems built up on a woody axis, bearing opposite small fleshy leaves and axillary clusters of small yellowish flowers with sepals but no petals. The glistening white berries are familiar as the Mistletoe decoration which is supposed to encourage the bashful male during the Christmas season. Mistletoe forms inaccessible clumps of evergreen foliage high up on the branches of various conifers and on oaks, sycamores and mesquite; found throughout western United States and in the East, from New Jersey to Texas. Mistletoe is particularly prominent in winter when



MONOTROPACEAE

Pinedrons, Pinesaps and Beechdrone.

the bright green plants form tufted masses on the leafless limbs of the deciduous trees.

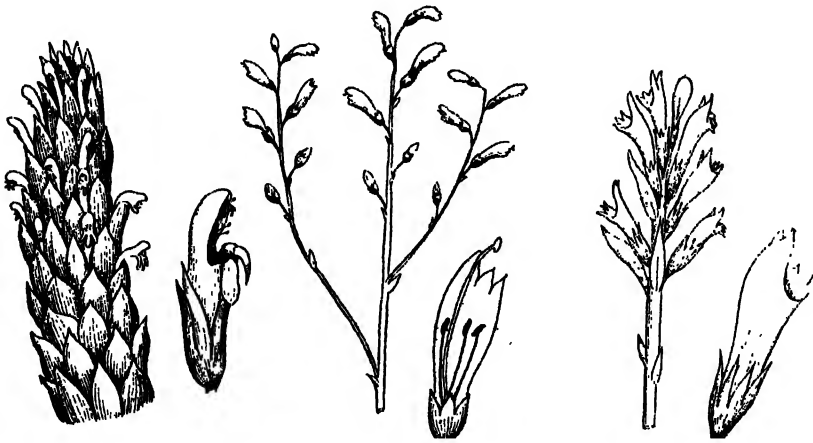
When a plant has no chlorophyll, it must do more than lean upon other plants for support or use them as a convenient source of water. Unable to manufacture its own organic food, such a plant must absorb it from one of two sources. If it becomes a saprophyte, it "feeds upon" humus and dead animal matter; if a parasite, it consumes the tissues of living organisms. We have already seen the diverse ways in which the Fungi have adapted themselves for preying upon living and dead protoplasm; just as the Algae are the most completely adapted aquatic organisms, so may the Fungi be considered well-adapted saprophytes and parasites. As we go on up the scale of plant complexity, through the Bryophytes and Pteridophytes, we find, strangely enough, few examples of degeneration to a dependent mode of existence. But with the Spermatophytes there is a great range of parasitism and saprophytism. In order to carry out this type of food-getting, such dependent plants have evolved a technique which to us often seems diabolical. Changes in the plant body also take place as old structures become useless and new ones necessary. The leaves are unnecessary, thus they are reduced to scales or entirely disappear. Stems become colorless, or tinged with brown or yellow—never green. And the roots assume new aggressive functions of



Mistletoe (*Phoradendron*) forms green clumps on the leafless limbs of Sycamores and other deciduous trees in the southern and southwestern states. Victorville, California.

piercing the host's outer tissues as well as new methods of food absorption by special suckers. Some of the Orchid Family and the entire Indian Pipe Family have become saprophytes; while Dodder, the Broom-rape Family and the tropical *Rafflesias* are examples of highly perfected parasitism.

It is not surprising that some of the Orchids have become saprophytes since they already have in their roots symbiotic fungi which might make the use of chlorophyll in the Orchid plant unnecessary. The Phantom Orchid (*Cephalanthera*), found in pine woods from California to Oregon, is a stout white plant with creeping rootstock and fleshy roots which absorb the organic material from the rich humus. The leaves are reduced to long sheathing bracts, and the entire plant is terminated by a spike of yellowish-white flowers, each with the lip and other floral parts typical of the Orchid



OROBANCHACEAE

Squawroot, Beechdrops and Broom-rape.

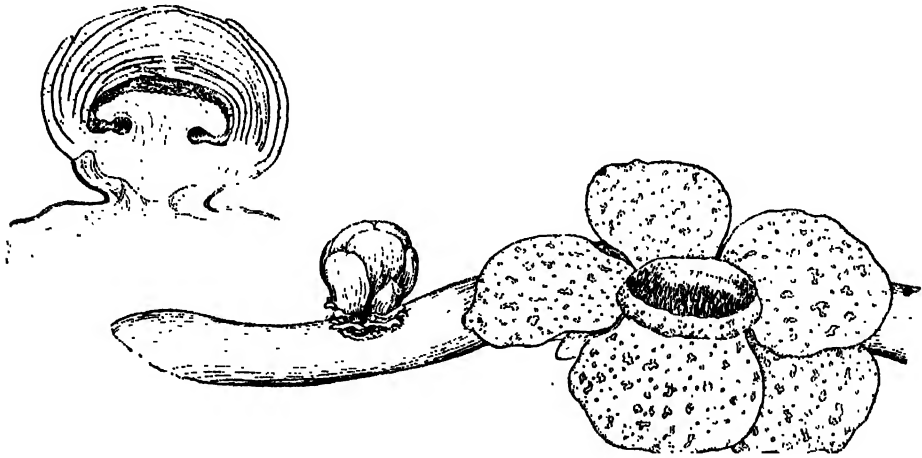
blossom. More widely distributed is the familiar Coral Root (*Corallorrhiza*), living in the rich humus of forests from coast to coast. This is a purplish- or reddish-brown plant, sometimes changing its habit to become parasitic upon roots, with small scale-like leaves and terminal clusters of white, yellow or brown flowers. Each flower has narrow petals, smaller than the sepals, and a dilated lobed lip. A southeastern member of the Orchid Family, found in rich woods from Maryland to Florida and Texas, is the brown stemmed Brunetta (*Hexalectris*), whose terminal cluster of flowers is brownish-yellow, striped with purple. The brown leaves are small and scale-like as in the other saprophytic Orchids.

The Indian Pipe Family (*Monotropaceae*) includes about sixteen, chiefly North American, plants which are for the most part saprophytes living on humus, though in some instances the plants become parasitic upon roots. They are all closely related to the Wintergreen and Heath Families. Botanists and laymen alike are always thrilled to find the waxy-white clusters of Indian Pipes (*Monotropa*) rising with ghostly grace amid the brown debris of dead leaves and stems. Because of the color, Indian Pipes are



Indian Pipes (*Monotropa uniflora*) are ghostly white plants of the eastern woodlands, mistaken for Fungi because of their lack of green leaves. Bridgton, Maine.

often thought of as Fungi by the average woodsman. The cluster of fleshy white or pink-tinged stems, each bearing colorless leaf scales, rise six to ten inches in height. Each plant produces a single terminal flower with two to four sepals and a half dozen white or pink petals; the flowers are nodding until fertilization has taken place, then they become erect. Indian Pipes are found in shaded woods practically throughout the United States. Pinesap (*Hypopitys*) is a closely related plant of yellowish-brown or pink color, with scaly stems and a nodding one-sided cluster of red or yellow flowers; each flower consisting of five petals and sepals. This saprophyte occurs in woods from New York to North Carolina. Pinedrops (*Pterospora*), a stout and clammy brownish-purple plant with the usual scale-like leaves and terminal cluster of nodding white



RAFFLESIACEAE

(Upper left), section of bud of *Rafflesia* growing out of host plant; (right), two *Rafflesia* blooms.

urn-shaped flowers, is more usually parasitic upon the roots of pines. Common along the Pacific Coast, this member of the Indian Pipe family is rare east of the Rocky Mountains. Carolina Beechdrops (*Monotropsis*), found in our southeastern states, is a purplish-brown saprophyte with clusters of violet-scented flowers which are white, pink or purple in color. Most colorful and striking of the family, however, is the bright red Snow Plant (*Sarcodes*) found in the rich humus of high altitude forests of southern and central California, particularly abundant beneath Sequoias and other conifers of the Sierras. Because of their early flowering habit, these blood-red saprophytes are often covered by a late spring snowfall, and thus get the name of Snow Plant. The stout fleshy stem is almost entirely covered by the masses of colorful flowers with five-lobed corollas, seated among projecting conspicuous bracts.

Dodder (*Cuscuta*) is one of our most common parasites, the leafless twining stems often covering shrubs and herbaceous plants with a tangle of bright orange threads. Dodder, a member of the Morning Glory Family, has almost two hundred species widely distributed throughout the world. Its distribution and number of species indicate how successful it has been in assuming the parasitic habit of living. The germi-



The Snow Plant (*Sarcodes sanguinea*) of Californian wooded mountains is a blood-red saprophyte of striking appearance. Mariposa Grove, Yosemite National Park, California.



Dodder (*Cuscuta*) is a leafless orange-yellow vine which gets its sustenance from green plants. Hemet, California.



Cancer Root (*Thalesia uniflora*) is a parasitic leafless Seed Plant of the Broom-race Family. White Plains, New York.

minating Dodder seed begins its life in the soil, but soon the rapidly elongating seedling stem reaches about for a convenient support ; if fortunate, it comes in contact with the living stem of a Flax or Clover plant, or perhaps a larger shrub. As if realizing that soon its store of reserve food will be exhausted, the yellow leafless stems coil about the host stem, and give off aerial roots here and there where they come in contact with the host. These roots are really suckers which are able to penetrate the bark and invade the living tissues of the host ; finally they make a union with the life-giving vascular bundles, and from this point the Dodder is assured of an easy life, absorbing food from its unfortunate host. Masses of the yellow or orange stems soon cover the entire plant with a network of wispy threads which might suggest to an imaginative naturalist the unkempt tangle of some witch's locks. When ready to reproduce, the Dodder develops clusters of yellowish-white flowers, each with a five-lobed bell-shaped corolla.

The Broom-rape Family (*Orobanchaceae*), related to the Nightshade and Bigonia Families of the sympetalous Dicots, is a group of plant parasites with two hundred species, especially abundant in the Northern Hemisphere. Broom-rape (*Orobanche*) of common occurrence in our eastern fields and meadows is generally one of several introduced European species ; there are many native species found west of the Rocky Mountains. Broom-rape is a relatively slender, yellowish- or purple-colored, plant with a few scale-like leaves and a terminal spike of urn-shaped flowers with two-lipped margin ; the curved corolla has an erect and two-lobed upper lip and a spreading three-lobed lower one. This genus is parasitic upon the roots of various plants such as clover and tomatoes. Cancer Root (*Thalesia*), found in rich woods from coast to coast, has a matted mass of subterranean rootstocks parasitic upon the roots of various deciduous plants ; delicate pinkish-brown flowering stalks bear solitary white or violet flowers with bell-shaped five-lobed corollas. Squawroot (*Conopholis*) is a stout yellowish or brownish plant, young specimens of which look much like erect spruce cones. The stout stem is densely covered with scales, the upper ones scattered among the yellowish flowers of the terminal spike. The two-lipped corollas have a concave upper lip and a spreading three-lobed lower one. Generally found at the base of oak trees, this parasite gets its nourishment from roots ; it is found from New England to Florida and Michigan. Beechdrops (*Leptammium*) has stiff and branching erect stems quite unlike the squat fleshy ones of other members of the family ; they are yellowish- or purplish-brown in color, and bear a few scale-leaves. The small flowers, with notched upper lips and acutely lobed lower ones, are scattered in clusters over the branches. Beechdrops is parasitic on the roots of Beech trees, and is found from New England to Michigan and Louisiana.

The acme of plant parasitism is to be found in the tropical family *Rafflesiaceae*, belonging to the Buttercup Order and found in tropical Asia. Here the entire root-stem-leaf plan of the Spermatophyte has been lost as the parasite has adapted itself to a mode of living which makes all these unnecessary. The seeds of a *Rafflesia*, carried by elephant's feet or by seed-eating animals, eventually find lodging against a horizontal root which lies close to the surface of the ground, or in a crevice of the trunk or branches. Penetrating the bark, the seed germinates into a circular band of tissue which completely surrounds the ring of vascular bundles ; externally all that is visible of the one-sided conflict is a ring-like swelling under the bark. Such a complete union is established between the tissues of the host and those of the parasite that it is difficult

to tell where one begins and the other leaves off. After absorbing nourishment and growing somewhat in size, the formless body of the *Rafflesia* develops buds which pierce the bark, this time in the reverse direction, and grow into blossoms. These flower buds are at first small, then attain the size of cabbages, and finally open in spectacular blooms three feet in diameter—a size which entitles them to compete with *Amorphophallus* for the title of the world's largest inflorescence. These huge blossoms, apparently springing full-blown from the host, are a striking contrast to the invisible and comparatively small vegetative body of the parasite. These fleshy bowl-shaped structures, with five immense lobes and an unpleasant odor, are produced by a species native to Sumatra.

CHAPTER XLVI

Miscellaneous Plant Families



IN AN attempt to make this introduction to the plant world as scientific as possible, families of plants have been considered in their taxonomic sequence, and related groups have been considered in their proper positions from the botanical viewpoint. But in order, at the same time, to make the subject matter less confusing, many families of minor importance or isolated position have been omitted. Some of these are described in this chapter.



HYPERICACEAE, TROPAEOLACEAE AND BALSAMINACEAE

Great Saint Johnswort, Nasturtium, Touch-me-not.

DICOT FAMILIES

The Birthwort Family (*Aristolochiaceae*) of the Buttercup Order includes two hundred widely distributed species of herbaceous plants and vines. Wild Ginger (*Asarum*) is a low-growing plant found in rich woods from New England to North Carolina and Kansas, with a pair of large heart-shaped leaves growing from a ginger-flavored rootstock. The brownish-purple flowers with a three-lobed calyx but no corolla, grow at the base of the leaves where they are often concealed by the debris of

the forest floor. Birthwort or Dutchman's Pipe (*Aristolochia*), ranging from the northeastern states to Minnesota, is a climber with large ovate leaves; a favorite for covering porches with rapidly growing foliage and vines. The basal part of each flower is S-curved like a pipe, with a brownish-yellow calyx. A species of *Aristolochia* from Central and South America, known as Pelican Flower, produces a large and unusual-shaped flower, whose S-curved white flower base and inflated wide-spread lip of the calyx look like a swan or pelican; the face of the calyx is purple blotched and has a wavy margin and a long tail.

The Tamarisk Family (*Tamaricaceae*) is a small group of African and Eurasian species; it includes Tamarisk (*Tamarix*), an evergreen shrub and tree which is widely grown in Florida, the Southwest and California in situations where the num-



SIMAROUBACEAE AND MELIACEAE

Alanthus, China-berry Tree.

ber of native trees is few. The gray-green foliage consists of drooping branches clothed with scale-like leaves, giving the effect of a wilted, long-needled pine. Small pink flowers are borne profusely in long plume-like clusters. This and the following family are grouped with the Violet and Tea Families in the order *Parietales*.

The St. Johnswort Family (*Hypericaceae*) includes some three hundred species of temperate and tropical herbs or shrubs; our native representatives are about thirty species of the St. Johnswort genus (*Hypericum*). These are often coarse-growing plants, with opposite or whorled leaves and yellow flowers with five sepals and five petals. Great St. Johnswort, found along streams of our northeastern states, has a small terminal cluster of showy flowers an inch or two in diameter. The Common St. Johnswort is a branching plant with terminal leafy clusters of numerous small yellow flowers; this is a European plant which has become naturalized in fields and along roadsides of the eastern states. The western Tinker's Penny, occurring in wet places from California to Washington, is a species which forms prostrate matted growths and bears salmon-colored few-flowered clusters.

The Geranium Order (*Geraniales*), of which we have become acquainted with the Geranium, Wood Sorrel and Rue Families, includes also the following five families.

The Nasturtium Family (*Tropaeolaceae*) is well known for its cultivated genus *Nasturtium* (*Tropaeolum*), whose scientific name is the Greek for "trophy", suggested by the shield-shaped leaves and helmet-shaped flowers; they include forty-five species of vines or spreading weak-stemmed plants native to Mexico, Chile and Peru. One species has been in cultivation in Europe since the seventeenth century. The flowers—orange or yellow, rarely purple or blue, in color—have one of the five sepals prolonged into a cornucopia-like spur; the upper two of the five petals are slightly different from the others.

The Creosote Bush Family (*Zygophyllaceae*) has some hundred and fifty species of shrubby trees common to warm temperate regions. Creosote Bush (*Larrea*) is the characteristic feature of the sparse vegetation of desert plains and slopes from Texas



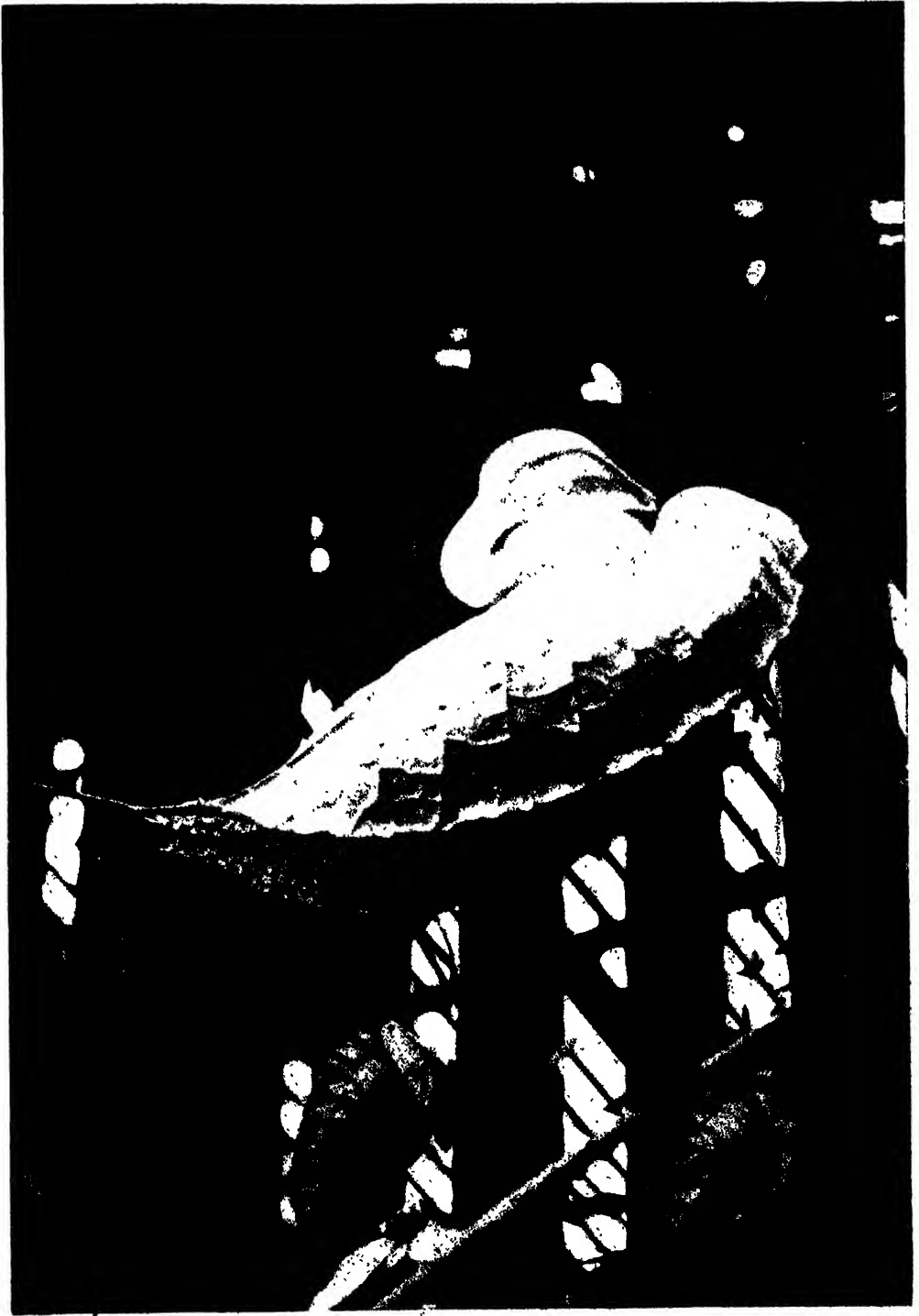
CELASTRACEAE AND PRIMULACEAE

Bittersweet, Shooting Star and Star Flower.

to Southern California. The tangle of branches bears opposite compound leaves, each with two small leaflets; the whole bush is olive-green in color, strongly scented and resinous. Small bright yellow flowers, with five sepals and five petals, are borne among the leaves. At the other corner of the United States, in the hammocks of the Florida Keys, grows the related genus *Lignum-vitae* (*Guaiacum*), a shrubby tree with hard strong heartwood, large compound leaves and blue flowers.

The Coca Family (*Erythroxylaceae*) is represented by the Coca plant (*Erythroxylon*) of tropical America, whose exact native home is unknown but was early found in Peru. It is a shrub with rusty-brown branches, entire and somewhat leathery leaves, and yellow flowers. From the leaves cocaine is secured, a valuable anesthetic but also one of the most habit-forming of drugs. The native Indians chew the leaves, mixed with lime. Coca plants are grown commercially in South America, Java and Ceylon.

The Ailanthus Family (*Simaroubaceae*) comprises numerous shrubs and trees abundant in the tropics, with one common native genus. Crucifixion Thorn (*Holacantha*) is a rigid thorny shrub of our southwestern deserts, with scale-like leaves and



Pelican Flower (*Aristolochia grandiflora*) has a startling resemblance to a swan or a pelican at rest, due to the S-curved basal portion of the flower. McKee Gardens, Vero Beach, Florida.

small flowers. Ailanthus or Tree of Heaven (*Ailanthus*), a native of China, has been introduced as a street and lawn tree throughout eastern United States. It is a medium-sized tree with opposite, pinnately compound leaves and clusters of showy flowers with five short sepals and five large greenish-white petals. The fruit is a winged seed.

The Mahogany Family (*Meliaceae*) is a large assemblage (seven hundred species) of tropical plants, two of which are worthy of mention. Mahogany (*Swietenia*) is an evergreen tree from Central and South America, and Africa, with pinnately compound leaves and clusters of small greenish-white flowers, some specimens reach a height of seventy-five feet. The hard, heavy and dark red heartwood is the familiar mahogany.



PRIMULACEAE

Swamp Candles, Fringed Loosetrife and Monardella

of commerce. The China-berry Tree (*Melia*) introduced from Asia is grown as a lawn tree in Florida and southern California, like the Mahogany it has compound leaves, but bears clusters of large, lavender flowers with the general appearance of Lilac blossoms.

The Jewelweed Family (*Balsaminaceae*) belongs to the Soapberry Order (*Sapindales*) which includes the Hollies, Maples and Horse Chestnuts. The several hundred species are most abundant in tropical Asia, our representatives are succulent herbaceous plants characterized by a peculiar seed dispersal habit. The fruit capsule splits into segments which remain attached to each other at the tip, so that the seeds are catapulted a considerable distance, the slightest touch at the tip of the capsule is sufficient to release the explosive mechanism. Wild Touch-me-not (*Impatiens*), found in low ground from New England to Florida and Nebraska, is a tall much-branched plant of purplish hue, with thin elliptical leaves and orange-yellow flowers mottled with brown. Each flower has a calyx of three sepals, one of which is petal-like and spurred, and a corolla of three petals, two of which are split into unequal lobes.



Star Flower (*Tricentris borealis*) is a white-flowered member of the Primrose Family, common in northeastern woodlands. Hamilton, New York.

Jewelweed is a stouter and taller plant with pale green foliage and yellow flowers with shorter spurs; it is found in practically the same range.

The Stafftree Family (*Celastraceae*) includes the decorative Climbing Bittersweet (*Celastrus*) which scrambles over stonewalls, fences and shrubs throughout eastern United States; the leaves are broad and entire, the small greenish flowers borne in clusters. In autumn the bright orange capsules which split open to display the scarlet seeds are a colorful aspect of the otherwise drab landscape.

The Primrose Family (*Primulaceae*) of the Primrose Order (*Primulales*) comprises about four hundred herbaceous plants of the northern hemisphere, characterized by flowers with four to nine partly united sepals, and a similar number of partly



EBENACEAE, SAPOTACEAE AND PLUMBAGINACEAE

Persimmon, Satinleaf, Sea Lavender.

united petals. Wild flowers of the family include Whorled Loosestrife, Swamp Candles, Moneywort, Fringed Loosestrife, Star Flower, Poor Man's Weatherglass and Shooting Star. Whorled Loosestrife (*Lysimachia*) is a slender erect plant with narrow elliptical leaves usually in whorls of four or five; long-stemmed yellow flowers are borne in the axils of the upper whorls. This species occurs in moist soil from New England to Georgia and Minnesota. Swamp Candles is a species with long tapering opposite leaves and a terminal spike of yellow flowers which are often streaked with purple; it is found in swampy woods from New England to Georgia. Moneywort is a naturalized European species with creeping stems and oval opposite leaves. Large yellow flowers are borne in the leaf axils. Fringed Loosestrife (*Scirouema*), a plant of moist thickets throughout the eastern states, has opposite pointed leaves and long-stalked yellow flowers, a half inch to an inch in diameter, in the upper leaf axils. Star Flower (*Tridentalis*) has slender erect stems less than six inches in height, terminated by a whorl of five to ten leaves amid which are seated several long-stemmed white flowers; this dainty plant frequents the shaded and moist woods of the northeastern states. Poor Man's Weatherglass (*Anagallis*), naturalized from Europe, forms prostrate masses with opposite or whorled rounded leaves and long-stemmed salmon-



The Bird of Paradise Flower (*Strelitzia reginae*) is an orange and blue imitation of a bird on the wing, soaring out of a boat-shaped structure which acts as the spathe for the flower cluster. Los Angeles, California.

represented in the United States by the Persimmon (*Diospyros*). This grows to be a seventy-five foot tree, with ovate leaves, greenish-white urn-shaped flowers, and an edible fruit. The latter is a reddish-orange fleshy berry the size of a peach, with sweet watery pulp. One species ranges from Florida and Texas north to Kansas, with an isolated station near New Haven, Connecticut. Commercial ebony comes from a species of *Diospyros* native to the East Indies and Ceylon, known for its black close-grained heartwood. The Sapodilla Family (*Sapotaceae*) comprises some five hundred tropical shrubs or trees with milky sap and in some cases edible fruits; a few



LOBELIACEAE AND CAMPANULACEAE

Indian Tobacco, Canterbury Bells.

of these range northward into the Florida peninsula. Here we find Satinleaf (*Chrysophyllum*), an evergreen shrubby tree with leaves which are silky hairy on their undersurface. Of interest to the gum-chewing portion of our population is the Chiclé Tree (*Sapota*) of the jungle forests of Yucatan and Central America, which furnishes the plastic basis of chewing gums.

We have already become familiar with that climax group of the Dicots, the *Compositae*; classified with them in the order *Campanulales* are the two families which follow. The Bellflower Family (*Campanulaceae*) is a large assemblage of a thousand species, herbaceous plants widely distributed through the temperate portions of the earth. Harebell (*Campanula*) is a slender wiry-stemmed plant with grass-like stem leaves and a graceful cluster of drooping blue bell-shaped flowers terminating hair-like stalks. Each flower has a spreading five-lobed calyx and five partly united petals. The Harebell is often found on rocky slopes and on dry cliffs, ranging from the



Wild Ginger (*Asarum canadense*) hides its inconspicuous reddish-brown flowers at the base of the two large heart-shaped leaves. Chittenango Falls, New York.

The Banana Family (*Musaccae*), with some seventy species, includes the striking Bird of Paradise plant, the Banana, Manila Hemp and Traveler's Tree. Bird of Paradise Flower (*Strelitzia*) is a South African plant cultivated out-of-doors in Florida, California and other of our warmer states. Among the stiff banana-like leaves are borne a half dozen orange and blue flowers in a boat-shaped spathe, from which arise several flowers with long tapering sepals and petals which give the effect of birds on the wing. The Banana plant (*Musa*) grows to be the size of a small tree, even though the stem is subterranean and what resembles a trunk is nothing but concentric leaf bases of the enormous feather-veined leaves—often a foot in width and five feet in length. The leaves are easily torn, and consist of frayed segments which show the effect of tropical winds. The flowers are borne on a huge nodding spike, three feet or more in length, with large purple bracts. The yellowish-white flowers, each with three sepals and three petals, develop into the banana; bananas are borne in the bunch which is often seen in markets. Each trunk bears one bunch of fruit, after which it dies; a new stem growing from the base. The banana is botanically an elongated berry, the remnants of the ovules (rarely fertile) being the minute black specks in the center of the pulp. A native of the Malay region, the Banana plant was early cultivated in India and was known to the Arabs and Greeks; it remained a curiosity until rapid means of transportation made it possible to bring the perishable fruit to market quickly. Our supply comes from Hawaii, the West Indies and Central America. Manila Hemp is a species of *Musa* with inedible fruit, native to the Philippines: the flower stalk and leaf bases furnish woody strands which are made into manila hemp fiber, stronger than but not as pliable as true hemp; it is used for making ropes and high grade cordage. Traveler's Tree (*Ravennala*) is a tall plant—frequently twenty-five feet in height—with a palm-like trunk and two ranks of huge banana-like leaves which form a flattened fan of foliage. When the lower leaf stalks are cut, the clear watery sap spurts forth like a fountain, and makes a refreshing drink. The Traveler's Tree is grown as a botanical rarity in southern Florida.

The Canna Family (*Cannaceae*) includes the single genus *Canna* with some forty species. Golden Canna is a native representative, found in swamps from South Carolina to Florida; it produces yellow flowers. Cannas are tall and large-leaved plants with showy flowers, the garden varieties coming from Mexico, Central and South America; often the leaves are a dark purplish-green. The flowers, mostly red or yellow, have three inconspicuous basal sepals, slightly larger pointed green or colored petals, and large showy petal-like stamens (mistaken for true petals) three of which are alike in size and a fourth which is narrow and forms a downward-pointing lip.

The Ginger Family (*Zingiberaceae*) includes numerous aromatic tropical plants, one of which (*Zingiber*) furnishes the ginger of commerce. Ginger is the dried finger-like rhizome of an Asiatic species, cultivated extensively in Jamaica for the American market.

The Arrowroot Family (*Marantaceae*) is also a tropical and subtropical group, represented in the swamplands from Florida to Texas by the large-leaved *Thalia* with spikes of purplish flowers. Arrowroot (*Maranta*) is a slender plant of the West Indies, whose tuberous rootstocks yield the starchy arrowroot of commerce.

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